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THE

SEAMAN's SURE GUIDE,

OR,

Navigator's Pocket Remembrancer:

WHEREIN ARE GIVEN

Such PLAIN INSTRUCTIONS in every uſeful Branch of NAVIGATION, as will in a ſhort Time form the

COMPLETE MARINER.

Among the Variety of eſſential ARTICLES contained in this WORK

ARE,

The Method of Working Tides, or finding High Water at any Place. —Geometry, and the Doctrine of Plain Triangles.—To make Log-Lines, and correct Diſtances given by Log when the Glaſs, Line, or both are faulty.—The various Sailings, with Amplitudes and Azimuths.—To find the Apparent and True Altitudes of the Sun, Moon, and Stars.—The different Methods of finding the Latitude. How to find the Apparent Time at Sea, to Regulate the Watch. —The new Method of finding the Longitude by Sun and Moon, or Moon and a fixed Star.—To rectify Courſes; with Rules for correcting the Dead Reckoning, by an Obſervation in all Caſes.— Exerciſing Examples of Days Works.—*A complete Log of a Ship's Voyage, with Inſtructions for writing a Journal from the Log Book,* &c. &c.

Upon an IMPROVED PLAN,
For the USE of SCHOOLS.

By J. BETTESWORTH,
MASTER of the NAVAL ACADEMY, CHELSEA, and late MATHEMATICAL MASTER of the MARITIME SCHOOL.

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CONTAINING

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Upon an IMPROVED PLAN,
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By J. [illegible]

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LONDON:

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ADVERTISEMENT.

THE Work here offered to the Public was undertaken with a view of furnishing Youth, intended for the Sea, and young Navigators, with plain practical Rules for qualifying them to go through their business with ease and regularity when on board ship, and likewise to serve as a full introduction in Schools, to the more extensive and sublime branches of Navigation.—It must not be considered, therefore, as a complete system of the science, the writer intended no more (which he hopes he has accomplished) than to give a clear explanation of all the fundamental and material parts of the art, on a plan different from all others that have yet appeared, and better adapted for enabling youth to work a day's work mathematically, and not by inspection, which is too generally the case; a method liable to continual errors.

The

The Title of REMEMBRANCER explaines in some degree the nature and use of this Treatise; it being designed to refresh the memory of young seamen with what they may have learned, and to serve as a certain and safe guide whenever they find themselves at a loss, or in doubt.

There are Rules to explain every question, and Examples worked to illustrate those Rules and Questions, by which such as are not adepts in this branch of mathematical knowledge, may, by a little attention, be fully grounded in the several parts more immediately necessary for their profession.

From the easy and regular manner of treating the whole, and the low price of the book, when compared with other productions of a similar kind, the Author flatters himself it will readily find admittance in Schools where Navigation is taught,

THE SEAMAN's PRACTICAL REMEMBRANCER.

ON WORKING OF TIDES, OR FINDING HIGH WATER AT ANY PLACE.

Q. HOW do you find any year of our Lord to be leap year?

A. Divide the year by four, if nothing remains it is leap year; but if one, two, or three remains, it is fo many years after leap year.

EXAMPLE. What is the prefent year 1783, a common or leap year?

4)1783

445—3

Anfwer.—A common year, and it is the third after leap year.

9+ B *Q.* How

Q. How do you find the prime, or golden number?

A. Add one to the year of our Lord, divide that sum by nineteen, the remainder is the prime, or golden number.

EXAMPLE. What is the golden number for the year 1783?

```
      1783
         1
      ----
  19)1784(93
     171
     ---
      74
      57
      --
Answer 17 the golden number
```

Q. How do you find the epact till the year 1800?

A. Substract one from the prime or golden number, multiply the remainder by 11, and divide that product (if it exceeds 30) by 30, the remainder is the epact.

EXAMPLE. What is the epact for the year 1783?

```
      1783                       17 golden No.
         1                        1
      ----                       --
  19)1784(93                     16
     171                         11
     ---                         --
      74                    30)176(5
      57                       150
      --                       ---
      17 The golden number  Anf. 26 The epact
```

Q. How

Q. How do you find the moon's age?

A. To the epact, add the number and day of the month, their sum, if under 30, is the moon's age; but if it exceeds 30, divide by 30, the remainder will be her age.—N. B. When the solar and lunar years begin together, the moon's age the first of each month, (or the monthly epact) is called the numbers of the month, which are as follows:

IN COMMON YEARS,

Jan.	Feb.	March	April	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.
0	2	0	2	2	4	4	6	7	8	10	10

IN LEAP YEARS.

Jan.	Feb.	March	April	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.
0	2	1	3	3	5	5	7	8	9	10	11

EXAMPLE. Of what age is the moon the 23d of March, 1783?

26 The epact found as before
0 No. of the month
23 Day of the month

30)49(1
30

Answer 19 days.

Q. How do you find the moon's southing, or her being on the meridian?

A. Multiply her age by 4, divide that product by 5, the quotient will be hours after mid-day, and the remainder (if any) so many 12 minutes.

EXAMPLE. At what time will the moon be on the meridian, the 23d of March, 1783?

Her age 19 days, found as before
4
—
5)76
—
15 : 12 moon's ſouthing
12 : 24
—
2 : 48

Anſwer at 48 minutes paſt 2 after mid-night

Q. How do you find the time of high water or full ſea, at any propoſed place?

A. To the moon's ſouthing add the flowings of the place, that is, the point of the compaſs the moon bears on full, and change days when high water at that place, which are as follows:

		Hrs.	Min.
North	and South	12	
N.byE.	— S.byW.		45
N.N.E.	— S.S.W.	1	30
N.E.byN.	— S.W.byS.	2	15
N.E.	— S.W.	3	
N.E.byE.	— S.W.byW.	3	45
E.N.E.	— W.S.W.	4	30
E.byN.	— W.byS.	5	15

East

		Hrs.	Min.
East	and West	6	
E.byS.	— W.byN.	6	45
E.S.E	— W.N.W.	7	30
S.E.byE.	— N.W.byW.	8	15
S.E.	— N.W.	9	
S.E.byS.	— N.W.byN.	9	45
S.S.E.	— N.N.W.	10	30
S.byE.	— N.byW.	11	15
South	— North	12	

N. B. Should this time not exceed 12 hrs. 24 min. (which is a tide) it is the time of high-water after mid-day; but when greater than 12 hrs. 24 min. take 12 hrs. 24 min. from it, and it will give the time of high-water after midnight: Lastly, when greater than two tides, that is, 24 hrs. 48 min. substract 24 hrs. 48 min. therefrom, the remainder is the time of high-water on the following day.

EXAMPLE. At what time will it be high-water at London-Bridge, the 23d of March, 1783?

Hrs.		Min.	
15	:	12	The moon's southing as before
2	:	37	London-Bridge flows N.E. by N. ½ E.
17	:	49	
12	:	24	
5	:	25	after midnight

Answer.—At 25 minutes past 5 after midnight.

To find the golden number, epact, moon's age, moon's southing, and the time of high-water at any place and time whatever, all under one.

RULES.

1st. Add one to the year of our Lord, divide that sum by nineteen, the remainder is the golden number.

2d. Substract one from the golden number, multiply the remainder by eleven, divide that product by thirty; whenever it exceeds thirty, the remainder will be the epact.

3d. To the epact, add the number of the month and the day of the month together, gives the moon's age.

4th. The moon's age, multiplied by four and divided by five, gives the moon's southing in hours; if there is a remainder, it is so many twelve minutes.

5th. To the moon's southing add the flowings of the place, and it will give the time of high water at that place, observing the N. B. Page 5 in finding the time of high water.—Observe--This Operation must be performed for the same year you find the golden number and epact for.

EXAMPLE.

What is the golden number and epact for this present year 1783? and what age is the moon, and when high water at London-Bridge, this 23d day of March, 1783?

1783

```
    1783
       1
   ------
19)1784(93
   171
   ----
     74
     57
   ----
     17 The golden number
      1
   ----
     16
     11
   ------
  30)176
   ------
      5 — 26 the epact
           o number of the month
          23 day of the month
          ---
       30)49(1
          30
          ---
          19 the moon's age
           4
          ---
        5)76
          --------
          15 : 12
          12 : 24
          --------
           2 : 48 the moon's southing
           2 : 37 London-Bridge flows
          --------
           5 : 25
```

Anfwer. High Water at 25 Minutes paft 5 after midnight.

MATHEMA-

MATHEMATICAL CHARACTERS OF ABBREVIATION, EXPLAINED.

+ Signifies More, as 2 + 4 is 2 added to 4.
— ——— Less as 3 — 2 is 2 taken from 3.
× ——— Multiply, as 6 × 4 is 6 multiplied by 4.
÷ ——— Divided by, as 8 ÷ 4 is 8 divided by 4.
= ——— Equal to, as A = 4 is A. equal to 4.
□ Or Sq. A Square, as □ ABCD is the Square ABCD.

A B
▭ — A Parallelogram, as ▭ is the Parallelogram ABCD.
C D

∠ ——— An Angle, as ∠ A is the Angle A.
C

△ ——— A Triangle, as △ is the Triangle ABC.
A B

.. ——— Is to or to } As 2 .. 4 :: 6 .. 12 that is,
:: ——— So is } As 2 is to 4, so is 6 to 12.

S, or S— Sine.
Co Sine, or SC Co Sine, or Sine Complement.
T, or Tang. Tangent.
TC, or Co Tang. Tangent Complement, or Co Tangent.
Sec. Secant.
Co Sec. Secant Complement, or Co Secant.
Co Ar. Complement Arithmetical.
d, or D, or O. Degrees.
M, or ′ Minutes.
″ —— Seconds.
‴ —— Thirds.
L — Leagues.
⊏ — Greater.
⊐ — Less.
2 √ — Extraction of the Square Root.
3 √ — Extraction of the Cube Rooot.

MATHE-

MATHEMATICAL TERMS EXPLAINED.

A DEFINITION gives a clear notion of a thing we would have signified.

A PROPOSITION is something proposed to be considered, and requires either a solution or answer, or that something be made out or proved.

A PROBLEM proposes something to be done or effected.

A THEOREM is a speculative proposition or rule, in which something is effected to be true.

By DEMONSTRATION is understood, the highest degree of proof that human reason can attain to.

An AXIOM is a self-evident truth, and has no need of a demonstration.

A COROLLARY is some conclusion gained from a preceding demonstration.

A LEMMA is the demonstration of something premised, whereby the proof in hand becomes the shorter.

A SCHOLIUM is a remark on some preceding proposition and demonstration.

A POSTULATE is a principle or condition required, the reasonableness of which cannot be denied.

ON

On GEOMETRY.

Q. What is Geometry?

A. It is a ſcience which treats of the deſcriptions, properties, and relations of magnitudes in general; or of ſuch things where length, or length and breadth, or length, breadth, and thickneſs are conſidered.

Q. How many kinds of magnitudes are there?

A. Three.

Q. What are their names?

A. Lines, Superficies, and ſolids.

Q. What is a mathematical point?

A. An aſſignable place in a plane, as at A.

Q. What is a line?

A. It has length without breadth, as A———B.

Q. What is a right line?

A. It is the ſhorteſt diſtance between two points, As C—B.

Q. What is a curv'd line?

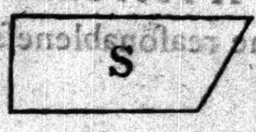
A. It is an indirect line, and not the ſhorteſt diſtance between two points, as A B.

Q. What are the boundaries of lines?

A. Points.

Q. What is a ſuperficies.

A. A magnitude, with length and breadth only, as S.



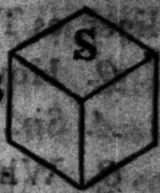
Q. What

Q. What are its boundaries?

A. Lines.

Q. What is a ſolid?

A. It has length, breadth, and thickneſs, as S

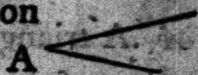


Q. What are its boundaries?

A. Superficies.

Q. What is a plane angle?

A. It is the aperture, or inclination of two lines, meeting in one point, or it is the interſection of two lines, as A



Q. How many kinds of angles are there?

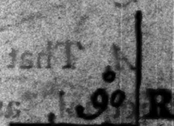
A. Three.

Q. What are their names?

A. A right angle, an obtuſe angle, and an acute angle.

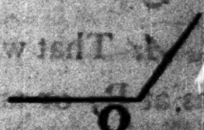
Q. What is a right angle?

A. It is an angle equal to 90 degrees, as R



Q. What is an obtuſe angle?

A. It is an angle greater or more than 90 degrees, as O



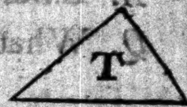
Q. What is an acute angle?

A. It is an angle leſs than a right angle as, A

Q. What

Q. What is a plane triangle?

A. A plain figure, bounded by three right lines, or it is the interſection of three right lines, as T.



Q. How many kinds of triangles are there?

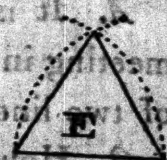
A. Six.

Q. What are their names?

A. Equilateral triangle, an iſoſceles triangle, a ſcalenum triangle, a right-angled triangle, an obtuſe-angled triangle, and an acute-angled triangle.

Q. What is an equilateral triangle?

A . A triangle whoſe lines or ſides are all equal, conſequently the angles all equal, as E

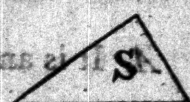


Q. What is an inſoſceles triangle?

A. That which has two equal ſides, conſequently two equal angles, as I

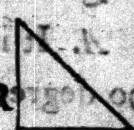
Q. What is a ſcalenum, or ſcalenous triangle?

A. That which has all its ſides and angles unequal, as S



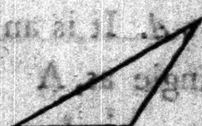
Q. What is a right-angled triangle?

A. That which has one right angle in it, as at R, or an angle equal to 90 degrees.

R


Q. What is an obtuſe-angled triangle?

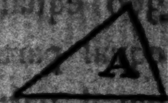
A. That which has one obtuſe angle in it, or an angle greater than 90 degrees, as at O


O

Q. What

Q. What is an acute-angle triangle?

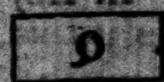
A. That which has all its angles acute or leſs than 90 degrees, as in the triangle A.



N. B. All triangles which have not a right angle, are generally called oblique; the longeſt ſide of a right-angled triangle, is called the hypothenuſe, and the other two ſides, legs. Angles and triangles (in general) are marked with three letters, the angular letter is always read the middle.

Q. What is a quadrangle?

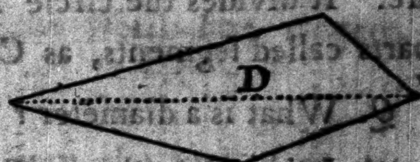
A. A plain figure, bounded by four right lines as Q.



Quadrangles having oppoſite ſides, parallel and rectangular, are commonly called parallelograms.

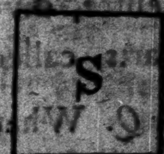
Q. What is a diagonal?

A. A line drawn through a quadrangle, from one angle to its oppoſite angle, as D.



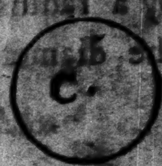
Q. What is a ſquare?

A. A figure with four equal ſides ſtanding at right angles, as S.



Q. What is a circle?

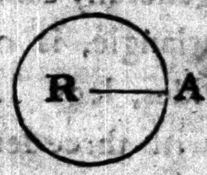
A. It is a plain figure, bounded by an uniform curved line, called a circumference, which is every where equally diſtant from one point, called its centre, as C.



N. B. The circumference of a circle is divided into 360 equal parts, called degrees; each degree into 60 equal parts, called minutes; and each minute into 60 equal parts, called ſeconds, &c. &c.

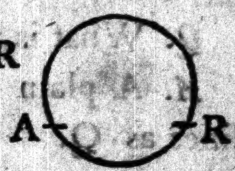
Q. What is the radius of a circle?

A. It is a right line drawn from the centre to the circumference, as R A



Q. What is the arc of a circle?

A. Any part of its circumference, as A R

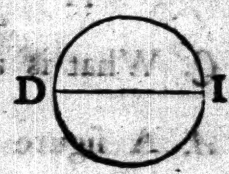


Q. What is a chord?

A. It is a right line joining the ends of an arc, It divides the circle into two unequal parts called ſegments, as C D

Q. What is a diameter?

A. It is a right line paſſing through the centre, dividing the circle into two equal parts, called ſemi-circles, as D I



Q. What is a quadrant?

A. It is half a ſemi-circle, and is made by a radius ſtanding perpendicular upon the diameter, as Q D or Q T

On PLANE TRIGONOMETRY.

Q. WHAT is plane trigonometry?

A. A ſcience which teaches us to compute the lengths of the ſides and quantities of the angles of plane triangles.

Q. How many things muſt be given in a triangle, to find the reſt.

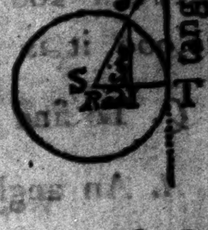
A. Three, which are either two ſides, and an angle oppoſite to one of them, or two angles and a ſide oppoſite to one of the given angles, or two ſides and the included angle, or the three ſides.

Q. What do you mean by the words ſine, tangent, and ſecant?

A. A ſine is a line drawn from the end of an arc perpendicular to the radius, as *s* I

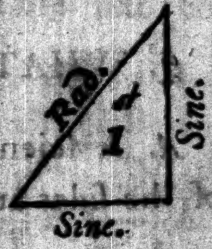
A tangent is a right line drawn perpendicular to the radius ſo that it touches it, and the periphery, as T t

A ſecant is a right line drawn from the centre thro' the circumference, by which the tangent is terminated, as S t

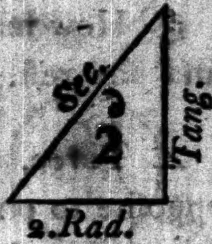


Q. In

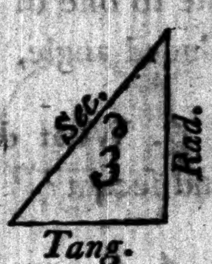
Q. In all right-angled triangles, if one ſide is made radius, what are the names of the other two ſides.



A. 1ſt. When the hypothenuſe is radius, then are the other two ſides ſines of their oppoſite angles, as in figure 1.



2d. When the baſe is radius, the hypothenuſe is a ſecant of the included angle between the baſe and hypothenuſe, and the perpendicular a tangent of the ſame angle or the angle oppoſite to it, as in figure 2.



3d. When the perpendicular is radius, the hypothenuſe is ſecant of the angle made by the perpendicular and the hypothenuſe, and the baſe a tangent of the ſame angle or of its oppoſite angle, as in figure 3.

Q. In working proportions by the logarithms, how am I to know the index to any given number?

A. The index of the whole numbers are as follows; if under 10 it is a cypher; between 10 and 100 it is 1; between 100 and 1000 it is 2; between 1,000 and 10,000 it is 3, &c. &c.

Q. To find a ſide what do you begin with?

A. An angle or radius.

Q. To

Q. To find an angle, what do you begin with?

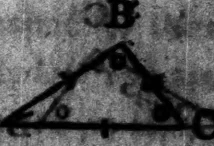
A. A ſide.

Q. In rectangled trigonometry after you make a ſide radius, how do you raiſe the proportion?

A. By ſaying, as the name of the given ſide (work'd from) is to its length, ſo is the name of the ſide required to its length, and the contrary.

Q. How do you know a given ſide or a given angle from one that is required?

A. Sides or angles which are given, are marked with a daſh; but when required, with a cypher, as per figure.



In this figure are given the ſides, A B and A C, and the angle A, required the angles B and C and ſide B C.

Q. How many degrees is the ſum of the angles of every triangle equal to?

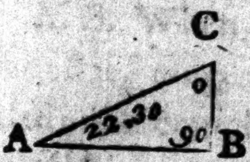
A. One hundred and eighty.

Q. In a right angled triangle, if one of the acute angles is given, how do you find the other acute angle?

A. By ſubtracting the given acute ∠ from 90 degrees.

EXAMPLE.

In the right ∠△ ABC $\left\{\begin{array}{l}\angle\ A\ 22^{\circ}.30' \\ \angle\ B\ 90\end{array}\right\}$ what is the ∠ C?



$$\begin{array}{rr} & 90 \\ \angle\ A & 22.30 \\ \hline \angle\ C & 67.30 \\ \hline \end{array}$$

A. ∠ C, is 67°.30′.

Q. If one angle in a triangle is given, how is the sum of the other two angles found?

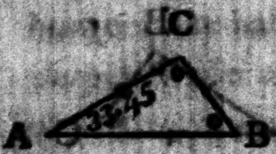
A. By subtracting the given angle from 180 degrees.

EXAMPLE.

In the oblique △ ABC the ∠ A 33 .45′, what is the sum of the angles B and C?

180°
33.45′

Answer. 146.15



Q. If two angles in a triangle are given, how is the third angle found?

A. By adding the two given angles together and subtracting their sum from 180 degrees.

EXAMPLE.

In the oblique △ ABC { ∠ A 22°.30′ / ∠ B 33 .45 } what is the angle C equal to?

∠ A 22°.30′
∠ B 33 .45

56.15
180

Answer. ∠ C 123.45

ON

On WORKING PROPORTIONS.

Q. How do you work proportions by the logarithms?

A. When direct, take the arithmetical complement of the first term, and add to it the logarithm of the second and third terms, abating 10 in the index; and it will be the logarithm of the fourth term or answer sought.

N. B. If radius is the first term, the index and logarithms are cyphers, but when it is the second or third term, the logarithm is cyphers, and the index 10; and again when the index of the first term is 10, in taking the arithmetical complement the index must be $\bar{1}$ (that is 1 bad or negative.) Now to find the arithmetical complement, begin at the index and write what each figure wants of 9, except the last, which take from 10.

Another Method to Work Proportions by the Logarithms when Direct.

Add the logarithms of the second and third terms together, from that sum subtract the logarithm of the first term, the remainder is the logarithm of the fourth term sought; but I make choice of the former method.

N. B. When an angle or arc is greater than 90 degrees, the sine, tangent, or secant of its supplement must be used; the complement of an arc or angle is found by subtracting it from 90 degrees, and the supplement from 180 degrees.

On

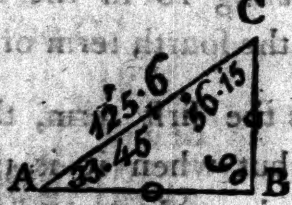
On RIGHT-ANGLED TRIGONOMETRY.

EXAMPLE.

In the right ∠ △ABC { AC 125'.6 / ∠A 33.45 } given { AB and BC } required.

90°
∠A 33.45'

∠C 56.15



Making AC rad. to find AB As radius 90° = 0.00000 .. AC 125.6' = 2.09899 : : S∠C 56.15 = 9.91985 .. AB 104.4 = 2.01884	Making AC rad. to find CB. As radius 90°. = 0.00000 .. AC 125 . 6 = 2.09899 : : S∠A 33.45 = 9.74774 .. CB 69 .78 = 1.84373
Making CB rad. to find AB As sec ∠C 56°.15' = 1.74474 .. AC 125 . 6 = 2.09899 : : tan.∠C 56 .15 = 10.17511 .. AB 104. 4 = 2.01884	Making CB rad. to find CB. As sec.∠C 56°.15' = 1.74474 .. AC 125 . 6 = 2.09899 : : rad. 90 = 10,00000 .. CB 69 .78 = 1.84373
Making AB rad. to find AB. As sec.∠A = 33°.45' = 1.91985 .. AC 125 . 6 = 2.09899 : : rad. 90 = 10.00000 .. AB 104 . 4 = 2.01884	Making AB rad to find CB As sec. ∠A 33°.45' = 1.91985 .. AC 125 . 6 = 2.09899 : : tang.∠A 33.45 = 9.82489 .. CB 69 .78 = 1.84373

CASE

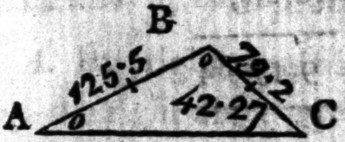
C A S E I.

Q. Having two ſides and an angle oppoſite to one of them given, or all the angles and one ſide given, how do you raiſe the proportions to find the other two angles or ſides?

A. In all plane triangles, the ſides are in juſt proportion to the ſines of their oppoſite angles and the contrary.

E X A M P L E.

In the oblique ∠ △ $\left\{\begin{array}{l} AB\ 125{,}5 \\ BC\ 79.2 \\ \angle C\ 42.27 \end{array}\right\}$ given $\left\{\begin{array}{c} \text{angles} \\ A\&B \end{array}\right\}$ requir-ed.



As AB 125. 5=7.90136
:: S∠C 42°.27=9.82927
:: BC 79 . 2=1.89872

:: S∠A 25.13′=9,62935

∠A 25°.1′3
∠C 42 .27

67 .40
180.

∠B 112 .20

C A S E II.

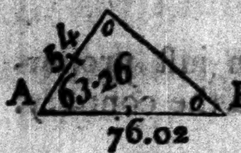
Q. Having two ſides and their containing angle given, how do you raiſe the proportion to find the other two angles?

A. In all plane triangles, as the ſum of the two given ſides is to their difference, ſo is tangent of half the ſum of the oppoſite angles to tangent of half their difference; the half difference added to the half ſum, gives the greater of the two angles, but ſubtracted from it, leaves the leſſer.

EXAM-

EXAMPLE.

In the obliq. ∠ △ABC $\left\{\begin{array}{l} AB\ 76^{\circ}.02' \\ AC\ 54 \\ \angle A\ 63^{\circ}.26 \end{array}\right\}$ given $\left\{\begin{array}{c} \angle B \\ \text{and} \\ \angle C \end{array}\right\}$ required.



180°.	AB=76.02
63 .26	AC=54
½)116.34 sum of op. ∠	sum 130.02
58.17 half do.	diff. 22.02

As AB+AC=130,02= 7 88602
.. AB—AC= 22.02= 1.34282
: : T½ sum oppo.∠=58°.17=10.20900
.. T½ their diff.=15 .18= 9.43784

∠C 73 .35

∠B 42 .59

CASE III.

Q. Having the three sides given, how is the proportion raised to find the three angles?

A. In all plane triangles, as the base is to the sum of the other two sides, so is their difference to the difference of the segments of the base made by a perpendicular, let fall from its opposite angle when it falls within the triangle, and added to the alternate base when it falls without.

In the first case, the half diff. of segments added to the half base, gives the greater segment, and subtracted, leaves the lesser; in the second case, the half diff. of segments added to the half base, gives the sum of the base and external base; but subtracted leaves the external base.

OR

ORTHUS.

As the longeſt ſide is to the ſum of the other two ſides, ſo is the difference of the two ſhorteſt ſides to the difference of the ſegments made by a perpendicular let fall from the angle oppoſite to the longeſt ſide, the half difference of the ſegments added to half the longeſt ſide gives the greater ſegment, and ſubtracted leaves the leſſer.

Q. Again, having found the two baſes made by letting fall the perpendicular from the angle oppoſite the longeſt ſide, how do you proceed to find the angles?

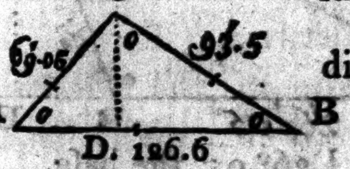
A. By right angled trigonometry, having two ſides and the right angle given.

EXAMPLE.

When the perpendicular falls within the triangle.

In the obliq. ∠ △ABC $\left\{\begin{array}{l}\text{AB } 126.6\\ \text{CB } 93.5\\ \text{AC } 69.05\end{array}\right\}$ given $\left\{\begin{array}{c}\text{Angs.}\\ \text{A,B}\\ \text{and C}\end{array}\right\}$ required.

CB	93.5	½)31.39	dif. ſeg.
AC	69.05		
		15.69	half dif. ſeg.
ſum	162.55	63.3	half baſe.
dif.	24.45	78.99	DB the gr. ſeg.
		47.61	AD the leſſer do.



As AB = 126.6 = 7.89757

: CB+CA 162.55 = 2.21085

:: CB−CA 24.45 = 1.38828

: diff. ſegms. 31.39 = 1.49670

As

As AD=47.61= 8.32230	As DB=78.99= 8.10243
.. Rad.=90° =10.	.. Rad.=90°. =10
: : AC=69.05= 1.83916	: : BC=93.5 = 1.97081
.. Sec.∠A 46.25=10.16146	.. Sec.∠B 32°.21=10.07324
∠B 32.21	
78.46	
180.	
∠C. 101.14	

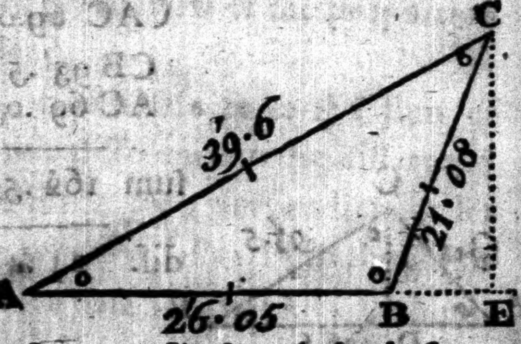
When the perpendicular falls without the triangle.

In the oblique∠ ∠ABC { AB=26′.05, AC=39 . 6, BC=21 .08 } given, the angles required.

AC=39.6
BC=21.08

60.68 sum of the 2 sides

18.52 their diff.



As AB =26′.05=8.58419
.. AC+BC=60 .68=1.78305
: : AC−BC=18 .52=1.26764

diff. seg.=½)43.14=1.63488

21.57

½)26°.05′ the base.

13 .025 half base.
21 .57′ half diff. seg.

34 .595 AE

8. 545 BE

As

As AE $= 34'.595 = 8.46105$
.. Rad. $= 90^{\circ}. = 10.00000$
: : AC $= 39 . 6 = 1.59769$

.. sec A $\angle = 29^{\circ}.08' = 10.05874$
90

$\angle$ACE $60 .52$

$\angle$ACE	$60^{\circ}.52$
$\angle$BCE	$23 .55$
$\angle$ACB	$36 .57$
$\angle$A	$29 .07$
	$66 .04$
	180
$\angle$ABC	$113 .56$

As BC $= 21'.08 = 8.67613$
.. Rad. $= 90^{\circ}. = 10.00000$
: : BE $= 8.545 = 0.93171$

.. S$\angle$BCE $= 23^{\circ}.55 = 9.60784$

DIRECTIONS FOR SURVEYING.

CASE I.

To survey a harbour by observations on the water.

RULES.

1st. Moor two buoys at commodious stations and measure their distance; from each station take the bearings of the most remarkable objects round the harbour near the water side, or errect station staves; set off on your paper the situation and distance of the two stations and the bearings of the objects from the stations; thro' the intersections of their bearings trace the coast line from station to station, then ornament it with a sketch of the appearance of the country; be sure that all the bearings are corrected by the variation of the compass.

 2d

2d. Let the ſoundings at low water be marked with ſmall figures, the time of high water on full and change days in Roman figures, and the ſetting of tides, currents, or eddies, by darts with their points the way they ſet; alſo inſert anchors in good anchoring ground.

3d. The commmon inſtrument uſed in ſurveying is the theodolite or azimuth compaſs.

N. B. When a harbour has turnings in it ſo extenſive, that all its principal points cannot be ſeen at two ſtations, moor as many buoys as are neceſſary, noting their bearings and diſtances, and drawing them (on your paper) in the manner of a traverſe; then take the bearings of the principal points, or objects from any two of them, whoſe bearings and diſtance are known, taking care that the object forms an angle with the two buoys of more than ſix degrees, for when lines lie very oblique, their interſections are not ſo eaſily or truly aſcertained—Again, if there ſhould be a bar, ſhoal, ſand, &c. each ſhould be taken by rowing round it, noting the courſe, diſtance, and ſoundings, and inſert them in the plan.

CASE II.

To ſurvey a harbour by obſervations on the ſhore.

RULES.

1ſt. Fix ſtation ſtaves at the moſt conſpicuous and remarkable points and bends of the ſhore.

2d. Chooſe a ſpot of level ground, on which meaſure with great exactneſs a baſe of a convenient length, from the extremes thereof obſerve the bearings of each object.

3d.

3d. If any of thoſe objects ſhould not make an angle of more than ſix degrees, or if the harbour is too large to be taken from one baſe, fix on another level ſpace, on which meaſure out a baſe from whoſe extremes the limits of the firſt baſe may be ſeen, or one limit and a ſtation ſtave whoſe bearing was obſerved from that limit; then proceed in taking the bearings of the remaining objects or ſtaves.

4th. More baſes may be meaſured if neceſſary, regard being had to the above directions; the diſtance from the limit of one baſe to that of the other baſe is eaſily known by trigonometry.

5th. If particular parts cannot be viewed from any of the ſtations, go round the parts, make ſketches thereof, and inſert them in their proper places in the general draught.

6th. If hills, trees, houſes, &c. intervene, the diſtance from each ſtation next that object to it, may be known by trigonometry.

C A S E III.

To take the draught of a ſea coaſt by ſailing along it.

R U L E S.

1ſt. Bring to, or caſt anchor at a convenient place to view the principal points, head lands, &c. take their bearings, and make a rough ſketch of the appearance of the coaſt.

2d.

2d. Sail in a direct line to another such station, noting the course and distance, during which time draw a more correct sketch of the coast.

3d. From the second station observe the bearings of the same head lands, &c. as before; and if required, more stations may be obtained the same way.

4th. Map the observations as before directed.

5th. Against each part of the coast, distinguish the appearance of rocks, windmills, cliffs, highlands, sand-hills, castles, &c.

6th. Express currents, eddies, anchorage, &c. as before.

7th. Draw a double line through dangerous sands, &c. and the most remarkable things on shore, or if possible, two remarkable things in a direct line, that the channel thro' them may be known, by which marks dangerous parts may be avoided.

N. B. If you want to copy a draught, divide the whole into exact squares with a black led pencil, then draw on your paper an equal number of squares, in such proportion as you want your draught, either exact, larger or smaller, as one half, one third, one fourth, &c. in each of the squares on your paper draw by the eye all things similar to the squares on the draught till the whole is copied; then rub out the black lead pencil lines with India rubber or bread.

INSTRUC-

INSTRUCTIONS TO MAKE LOG LINES.

The log is a flat piece of wood in ſhape of a ſector, and on its circular ſide there is a ſufficient quantity of lead to make it ſwim upright in the water, and to it is faſtened a line of 50 or 60 fathoms, called the log line, which is divided into equal parts, called knots; each of which bears a like proportion to a nautical mile, as half a minute does to an hour. Now to make a log line to a half minute glaſs, the ſpace from knot to knot is 50 feet, altho' a juſt proportion is 51 feet; but as it is found by experience that 51 feet would be too much, it being much ſafer to have a ſhip's reckoning before than after her, therefore 50 feet is allowed the proper length of each knot to an half minute glaſs, the knots being to be counted at 10, 12 or 14 fathoms from the log, as it may be clear of the ſhip, her wake, &c. Before they begin to count (the log line) from whence they begin to reckon, there is a piece of red rag, from which place is reeved between the ſtrands of the log line pieces of twine with knots on it from 1 to 5, 6 or 7, &c. to ſhew the ſhip's rate of ſailing; but ſhould the ſhip ſail ſo faſt as to run the log line off the reel before the half minute glaſs is out, in that caſe they generally make uſe of a quarter minute glaſs and ſo double every knot.

N. B. Be ſure great care is taken to meaſure the log line very often for fear it ſhould have ſtretched and ſo deceive you in the true diſtance ſailed.

INSTRUC-

INSTRUCTIONS to correct Diſtances given by the Log Line and Half Minute Glass.

CASE I.

When the Glass is faulty.

RULE.

As the ſeconds run by the glaſs is to 30 ſeconds, ſo is the diſtance run by the log, to the true diſtance.

EXAMPLES.

Suppoſe a ſhip runs at the rate of $5\frac{1}{2}$ knots per log, but meaſuring the glaſs finds it runs 35 ſeconds, what was the true diſtance ſailed?

As 35″ . . 30″ : : 5′.5 . . 4′.7 miles, the true diſtance ſailed.

```
        30
    ───────
35)165.0(4.7
   140
   ───
    250
    245
    ───
      5
    ───
```

Again, a ſhip ſails per log $7\frac{1}{2}$ knots per hour, but finding the glaſs to run only 25 ſeconds, what was the true rate of the ſhips ſailing?

As 25″ . . 30″ : : 7′.5 . . 9′ miles, the true diſtance ſailed.

```
        30
    ───────
25)225.0(9
   225
   ───
   ...
   ───
```

CASE

CASE II.

When the Log Line is faulty.

RULE.

As 50 feet is to the diſtance meaſured between knot and knot, ſo is the diſtance run per log, to the true diſtance.

EXAMPLE.

Suppoſe a ſhip runs at the rate of 6 miles por hour by the half minute glaſs, but meaſuring the log line finds it from knot to knot 55 feet. Required the true rate of her ſailing.

```
   feet   feet
As 50 . . 55 : : 6′ . . 6′.6 miles, the true diſtance ſailed.
           6
          —
   5|0)33|0
        ———
        6,6
        —
```

Again, a ſhip ſails per log 4½ knots per hour, by a half-minute glaſs, but finding the log line to meaſure from knot to knot only 45 feet; what was the true rate of her ſailing?

```
   feet   feet
As 50 . . 45 : : 4′.5 . . 4′.05 miles, the true diſtance ſailed.
          4.5
         ————
          225
         180
         ————
   5|0)20|2.5
         ————
         4.05
         ————
```

CASE

C A S E III.

When both the Log Line and Glass are faulty.

R U L E.

Multiply 3 times the meaſured length of a knot by the diſtance run per log, that product divided by 5 times the ſeconds that the glaſs runs, will give the true diſtance.

E X A M P L E.

Suppoſe a ſhip ſails 6 knots per log line of 45 feet to a knot, while a glaſs is but 25 seconds running out: What is the ſhip's true rate of ſailing?

```
25''                45 feet
 5                   3
---                 ---
125                 135
                      6
                  ------
               125)810.00(6.48 miles.
                   750
                   ---
                   .600
                   .500
                   ----
                   1000
                   1000
                   ----
```

Anſ. 6.48 miles, her true diſtance ſailed per hour, which is nearly 6½ miles.

A TABLE

A TABLE, shewing how to make LOG LINES in a just PROPORTION to different GLASSES from 22 Seconds to 38 Seconds.

To make the TABLE.

RULE.

Multiply the seconds in the glass by 5, and divide that product by 3, which gives the length of the log line in feet to one knot.

TABLE.

Glasses.	Length of Log Line to 1 Knot.	
Seconds.	Feet.	Inches.
22	36 „	8
23	38 „	4
24	40 „	0
25	41 „	8
26	43 „	4
27	45 „	0
28	46 „	8
29	48 „	4
30	50 „	0
31	51 „	8
32	53 „	4
33	55 „	0
34	56 „	8
35	58 „	4
36	60 „	0
37	61 „	8
38	63 „	4

Before

Before I enter upon navigation I would recommend to every young artist to learn the few, but necessary, following Sea Terms, &c.

Q. What do you mean by Starboard?

A. It signifies to the right hand or side.

Q. What do you understand by Larboard?

A. The left hand or side.

Q. What is the meaning of Forward or Afore?

A. It is towards the stem or head.

Q. What is Aft or Abaft?

A. That is towards the stern or hinder part of the ship.

Q. What is the meaning of the word Beam?

A. It signifies athwart or across the middle of the ship.

Q. If a ship sails with the wind directly across her, how is she said to have the wind?

A. On her beam; and when so sailing she is always 8 points from the wind.

Q. If a ship sails as near the wind as possible, how is she said to sail?

A. Close haul'd.

Q. What do you mean by Windward or Weather side?

A. It is the side of the ship on which the wind blows.

Q. What is weather gage?

A. To Windward.

Q. What do you mean by Leeward or Lee Side?

A. It is the contrary side of the ship on which the wind blows.

Q. When

Q. When is a ſhip ſaid to have her Starboard Tacks on board?

A. When her ſtarboard ſide is to windward.

Q. When is ſhe ſaid to have her Larboard Tacks on board?

A. When the wind blows on her larboard ſide.

Q. How do you find how near a ſhip or veſſel, &c. will lie to the wind?

A. By obſerving how ſhe goes on each tack when cloſe hauled; then half the number of points between the two courſes will ſhow how near the wind that ſhip or veſſel will lie.

ON NAVIGATION.

Q. WHAT is navigation?

A. It is the art of piloting a ſhip through the ocean, diſcovering the latitude, longitude, courſe, and diſtance made good upon various courſes, and how to ſteer to any known port, &c. &c.

Q. What is latitude?

A. The neareſt diſtance that any place may lie from the equator, for latitude begins at the equator and ends at the poles; conſequently the greateſt latitude is 90 degrees.

Q. What

Q. What do you mean by the equator?

A. It is a great circle on the earth's surface, equally distant from each pole; and it divides the globe into two equal parts called hemispheres.

Q. How many poles are there, and what are they?

A. Two: that on the north side of the equator is called the north pole, and the other which lies on the south side of the equator, the south pole. They are two points on the earth's surface, diametrically opposite to each other, and each 90 degrees every way distant from the equator.

Q. What is the difference of latitude?

A. It is an intercepted arc of a meridian between two parallels of latitude which can never exceed 180 degrees, or it is the nearest distance between two parallels of latitude.

Q. What do you mean by meridians?

A. They are immaginary circles on the earth's surface passing through both poles, standing at right angles to the equator.

Q. What is longitude?

A. Longitude on the earth is an arc of the equator, shewing the east or west distance of a place from some fixt meridian where longitude is reckoned to begin, and it never can exceed 180 degrees. When it is to the eastward of this fixt meridian, it is called east longitude; but when to the westward, west longitude.

Q. What is difference of longitude?

A. It is an intercepted arc of the equator shewing the distance between the meridians of any two places.

Q. Sup-

Q. Suppoſe a ſhip ſails towards the eaſt or weſt until ſhe paſſes the oppoſite meridian or 180 degrees, does ſhe change her longitude?

A. Yes, ſhe then comes into a longitude of a contrary name, which is found by ſubtracting the given longitude from 360 degrees.

Q. Suppoſe a ſhip ſails from the equator towards the north or ſouth poles, are the degrees of longitude (in all latitudes) equal to that on the equator?

A. No: they decreaſe in proportion to the following table.

A TABLE.

Shewing how many Miles anſwers to a degree of Longitude in every degree of Latitude.

N. B. At or on the Equator a Degree is equal to 60 Miles.

Deg. of lat.	Miles.	Deg. of lat.	Miles.	Deg. of lat.	Miles.	Deg. of lat.	Miles.	Deg. of lat.	Miles.
1	59.99	19	56.73	37	47.92	55	34.41	73	17.54
2	59.96	20	56.38	38	47.28	56	33.55	74	16.53
3	59.92	21	56.01	39	46.62	57	32.68	75	15.52
4	59.86	22	55.63	40	45.95	58	31.79	76	14.51
5	59.77	23	55.23	41	45.28	59	30.90	77	13.50
6	59.67	24	54.81	42	44.59	60	30.00	78	12.48
7	59.55	25	54.38	43	43.88	61	29.09	79	11.45
8	59.42	26	53.93	44	43.16	62	28.17	80	10.42
9	59.26	27	53.46	45	42.43	63	27.24	81	9.38
10	59.08	28	52.97	46	41.68	64	26.30	82	8.35
11	58.89	29	52.47	47	40.92	65	25.36	83	7.32
12	58.68	30	51.96	48	40.15	66	24.41	84	6.28
13	58.46	31	51.43	49	39.36	67	23.45	85	5.23
14	58.22	32	50.88	50	38.57	68	22.48	86	4.18
15	57.95	33	50.32	51	37.76	69	21.50	87	3.14
16	57.67	34	49.74	52	36.94	70	20.52	88	2.09
17	57.37	35	49.15	53	36.11	71	19.54	89	1.05
18	57.06	36	48.54	54	35.26	72	18.55	90	0.00

Q. By

Q. By what rule was the preceding table calculated?

A. { As radius
Is to ſine complement of any latitude;
So is 1 degree on the equator equalling 60 miles,
To the miles of longitude, anſwering to 1 degree in ſuch latitude.

For EXAMPLE.

Let it be raquired to find how many miles of longitude anſwer to a degree in the latitude of 51°.32′

90°.	As radius	= 90°.	= 0.
51 .32	∴ S. comp. of lat.	= 38 .28	= 9.79383
	∷ One degree	= 60′.	= 1.77815
38 .28			
	∴ Miles required	= 37′ .32	= 1.57198

N. B. From the preceding table, it is obvious that meridians are circles meeting in the poles, and as they approach the poles every degree of longitude is leſs, ſo that at the poles longitude is nothing; again, a ſhip's true place at ſea depends intirely upon her diſtance from the equator, and ſome fixt meridian, therefore it is highly neceſſary every mariner ſhould be able to aſcertain the miles of longitude anſwering to a degree in all latitudes.

Q. What is the meaning of the word horizon?

A. It is that apparent circle which limits the ſpectator's view on the ſea, whoſe eye is ever ſuppoſed to be in the centre of the horizon.

NAUTICAL OBSERVATIONS.

Q. Suppose you have the latitudes of any two places given, how do you find the difference of latitude?

A. If the latitudes are of one name, that is both north or both south, their difference is the difference of latitude required.——But if of contrary names, their sum will give the difference of latitude.

EXAMPLE.

What is the difference of latitude between London in lat. 50°.32′ N. and Gibraltar in lat. 36°.12, North.

London's lat.	50 .32′ N.
Gibraltar's lat.	36 .06 N:
Anf.	14 .26

What is the difference of latitude between London and the River Plata?

London's lat.	50°.32′ N.
River Plata's lat.	36 .00 S.
	86 .32
	60
Anf.	5192 Miles.

Q. Sup-

Q. Suppoſe a ſhip ſails from any latitude and makes difference of latitude, how do you find what latitude the ſhip is arrived at?

A. If the given latitude and difference of latitude are of the ſame name, their ſum is the latitude of the like name.—But if the given latitude and difference of latitude are of contrary names, their difference is the latitude required, of the ſame name as the greater.

EXAMPLE.

A ſhip from latitude 46°.30′ N. ſails northward until her difference of latitude be 164 miles, what latitude is the ſhip in?

Latitude ſailed from 46°.30′ N.
Difference of lat. 164′ ÷ 60 = 2 .44 N.

Anſwer, lat. in = 49 .14 N.

A ſhip from latitude 36°.15′ S. ſails northward until her difference of latitude be 136 miles, what latitude is the ſhip come to?

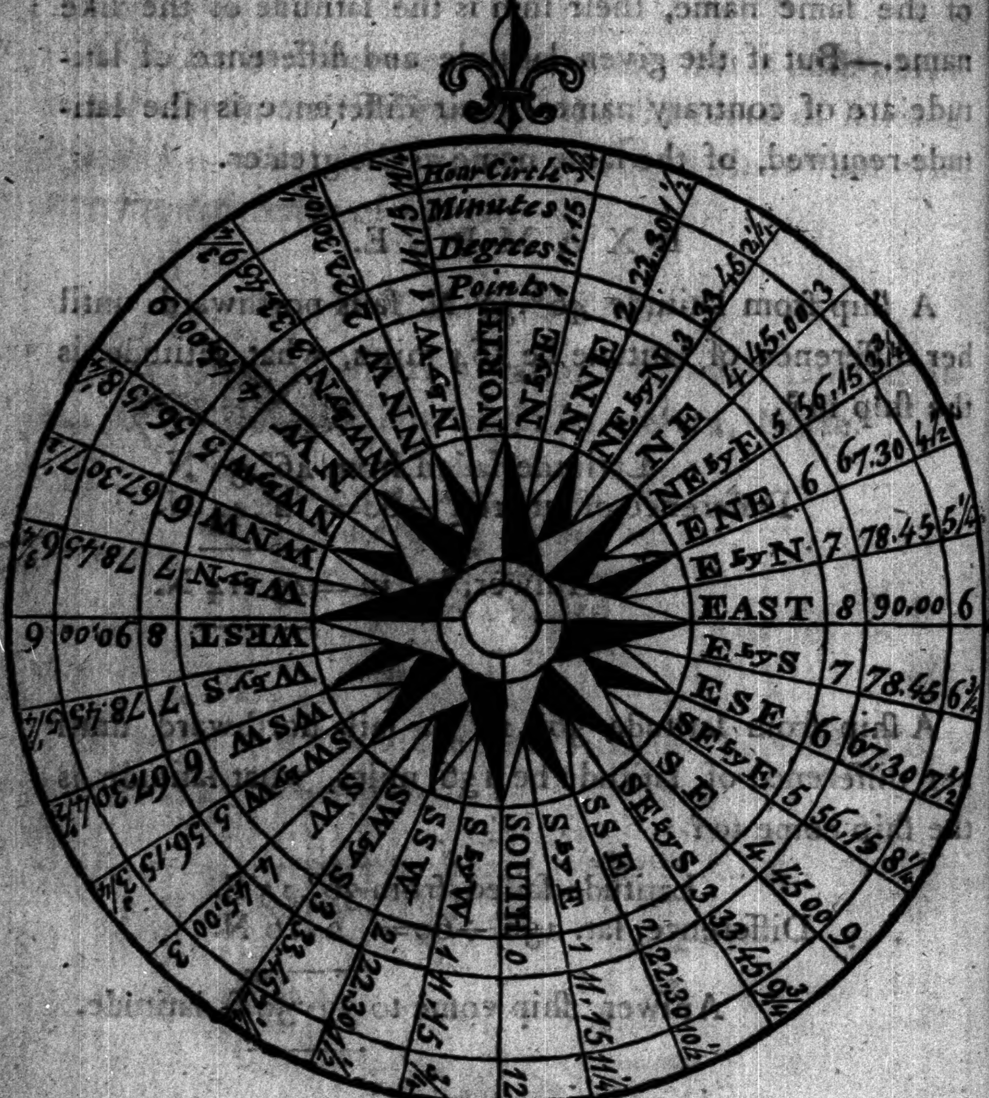
Latitude ſailed from 36°.15′ S.
Difference, lat. 136′ ÷ 60 = 2 .16 N.

Anſwer, ſhip come to 33 ·59 S. latitude.

A COMPLEAT COMPASS.

Repeat the compass as per figure.

N. B. Read N. for north, E. for east, S. for south, and W. for w



A TABL

A TABLE *of the* ANGLES *which every Quarter of a Point makes with the Meridian.*

North.	South.	Points.	Deg.		Min.	North.	South.
		¼	2	„	49		
		½	5	„	37		
		¾	8	„	26		
N by E	S by E	1	11	„	15	N by W	S by W
		1¼	14	„	4		
		1½	16	„	52		
		1¾	19	„	41		
NNE	SSE	2	22	„	30	NNW	SSW
		2¼	25	„	19		
		2½	28	„	7		
		2¾	30	„	56		
NE by N	SE by S	3	33	„	45	NW by N	SW by S
		3¼	36	„	34		
		3½	39	„	22		
		3¾	42	„	11		
NE	SE	4	45	„	00	NW	SW
		4¼	47	„	49		
		4½	50	„	37		
		4¾	53	„	26		
NE by E	SE by E	5	56	„	15	NW by W	SW by W
		5¼	59	„	4		
		5½	61	„	52		
		5¾	64	„	41		
ENE	ESE	6	67	„	30	WNW	WSW
		6¼	70	„	19		
		6½	73	„	7		
		6¾	75	„	56		
E by N	E by S	7	78	„	45	W by N	W by S
		7¼	81	„	34		
		7½	84	„	22		
		7¾	87	„	11		
East.		8	90	„	00	West.	

ON

ON PLAIN SAILING.

Q. What is plain ſailing?

A. The application of rectangled trigonometry.

N. B. In ſolving plain ſailing queſtions you will call the hypothenuſe the diſtance run, the perpendicular the difference of latitude, which is always north or ſouth, and the baſe the departure, and that is always eaſt or weſt; the angle oppoſite the departure or baſe repreſents the courſe, and that oppoſite the difference of latitude or perpendicular, the complement of the courſe.

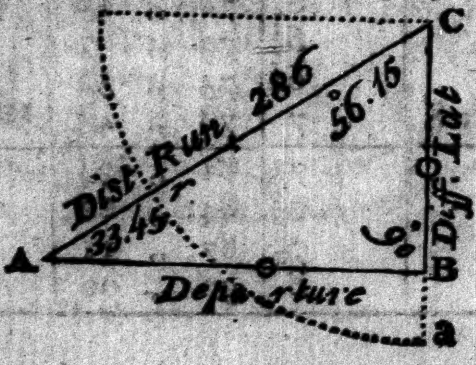
EXAMPLE.

A ſhip from the latitude of 42°.30′N. ſails S W by W. 286 miles, what latitude is ſhe arrived in, and what departure hath ſhe made?

To PROJECT the FIGURE.

RULE.

Draw the meridian or difference of latitude (which is always north and ſouth) then with a chord of 60 degrees from C deſcribe an arc, repreſenting the quarter the ſhip ſails in, on which arc ſet off the courſe the ſhip ſails (viz.) S W by W. equal 56°.15′ or 5 points from a to *r*, through the place where it cuts the arc draw the diſtance line CA equal to 286 miles (from any ſcale of equal parts,) then in manner as you would let fall a perpendicular from A on CB, draw AB the departure, then will the figure be projected.



In

In making the distance run radius it will be,

As rad. 90°. =0.00000	As rad, 90°. =0.00000
.. dist. 286′ =2.45637	.. dist. 286′ =2.45637
:: f. co. cou. 33°.45=9.74474	:: f. cou. 56°.15=9.91985
.. dif. lat. 6.0)158′. 9=2.20111	.. dep. 237′. 8=2.37622
2 .39	

Lat. sailed from 42°.30′ N.
Difference lat. 2 .39 S.

Latitude in 39 .51

Answer. Latitude in 39°.51′ N. departure 237′.8 West.

EXERCISING EXAMPLES in PLAIN SAILING.

A ship sails SW by S. from the latitude of 50° N. into the latitude of 49°.08′ N. what distance hath she sailed, and how far hath she departed from the meridian?

A. Her distance sailed is 62,54 miles, and her departure from the meridian is 34.75 miles.

A ship from the latitude of 47°.20′ N. sails between the north and east 98 miles, and then finds herself in latitude 48°.42 north; what course has she steered and what departure has she made?

A. Her course was N. 33°.12′ E. and her departure 53.66 miles.

A ship from latitude 48°.32′ N. sails between the north and west till her departure is 54 miles, and then finds herself to be in latitude 49°.54′ north; what course did she steer, and what distance did she run?

A. The

A. The courſe ſteered was NW by N. nearly, that is N. 33°.22′ W. diſtance 98.18 miles.

A ſhip from 32°.25′ north latitude, ſails between the north and weſt 496 miles, until her departure is 412 miles; what courſe has ſhe ſteered, and what latitude is ſhe arrived at?

A. Her courſe ſteered was N. 56°.10′ W. or NW by W. and her latitude arrived at 37°.01′ north.

A ſhip from the latitude of 40°10′ N. ſails NE by N. ¼ E. until her departure be 33 miles; I demand the diſtance ſailed, and the latitude the ſhip is arrived at?

A. Her diſtence ſailed 55.39 miles and her latitude arrived at 40°.54′ N. nearly.

ON TRAVERSE SAILING.

Q. What is travers ſailing?

A. It is when a ſhip, veſſel, &c. meets with contrary winds, by means of which ſhe is obliged to ſail on various courſes.

Q. What is reſolving a traverſe?

A. It is reducing ſeveral courſes into one, finding thereby the courſe and diſtance made good upon her different courſes ſteered.

Q. How are traverſe queſtions projected?

A. Three different ways.

1ſt. By

1ſt. By drawing new meridians through the extremity of every courſe (parallel to the firſt meridian) then by laying off the courſe and diſtance, as in plain ſailing.

2d. By laying down the quantity of the angles (after the firſt courſe is drawn) between the point next to be laid down, and the point oppoſite the courſe laſt drawn and ſo proceeding till the whole is finiſhed.

3d. Having a circle deſcribed, and divided like the mariners compaſs, you may draw the ſeveral courſes parallel to the rhumbs in the compaſs, and lay off the diſtances; which being done, a line drawn from the place the ſhip departed from, to the place ſhe arrived at, is the diſtance; and the angle which this line makes with the meridian, is the direct courſe; the ſame is to be underſtood in the two former methods.

DIRECTIONS for working TRAVERSES *by the Table of Difference of Latitude and Departure.*

1ſt. Draw columns for the courſes and diſtances, northing, ſouthing, eaſting and weſting, as per table, in which write down each courſe and diſtance ſailed.

2d. Look into the table of difference of latitude and departure for each courſe and diſtance, and agreeable thereto inſert it in the traverſe table, as you might have ſailed either in the NE. NW. SE. or SW. quarters, and when you have finiſhed the whole, add up the northing, ſouthing, eaſting, and weſting, according as you may have ſailed.

3d. Should

3d. Should there be northing and southing (in the traverse table) subtract the less from the greater, as also do the like respecting the easting and westing, it will then give you the whole true difference of latitude and departure.

EXAMPLE in working TRAVERSES.

Suppose a ship sails on the following correct courses, (viz.) SW. 70′, SSW. 46′, then due south 50′, and lastly, S by E. 42′, required her whole true difference of latitude and departure?

Having drawn the traverse table and wrote in it each course, (viz.) SW. 4 points or 45° distance 70′, then SSW. 2 points or 22°. 30′ distance 46′. &c.—look into the table of difference of latitude and departure for 4 points or 45°, and against 70 the distance column, you will find 49.5 latitude and 49.5 departure, which insert in the table under the southing 49.5 for latitude, and under the westing 49.5 for departure. Again, seek for 2 points, or 22°.30′, and against 46′ the distance you will have 42.5 lat. and 17.6 departure, which also place in the traverse table under southing 42.5 for latitude, and under the westings place 17.6 for the departure, &c. &c.

N. B. Should any of your courses be due north, east, south, or west, in that case you place the distance sailed, if north, under the northing column, if south, under the southing column, &c. and when sailing in the

the NE. quarter, you muſt ſet the latitude under the northing, and the departure under the eaſting; but if ſailing in the SW. quarter, you muſt place the latitude under the ſouthing, and the departure under the weſting columns, &c. &c. ever obſerving to place latitude either under the northing or ſouthing columns, and departure under the eaſting or weſting columns according to the quarter of the compaſs in which you may have ſailed in.

THE TRAVERSE TABLE.

Courſes corrected.	Points.	Diſt.	N.ing.	S.ing.	E.ing.	W.ing.
SW.	4	70	——	49.5	——	49.5
SSW.	2	46	——	42.5	——	17.6
South.	0	50	——	50.0	——	——
S by E.	1	42	——	41.2	8.2	——
				183.2	8.2	67.1
			Diff. lat.			8.2
						58.9
						Departure.

EXAMPLE.

A ſhip in the channel ſets the Lizard NE. 4 leagues, then ſails SW. 50 leagues, then SW by S. 42, then South 45 leagues, and laſtly SSW. 56 leagues; what is the bearing and diſtance of the Lizard, and what latitude is the ſhip in, ſuppoſing her courſes all correct?

To Project the Figure.

RULE.

Draw the meridian or north and ſouth line, and with the chord of 60 degrees deſcribe the quarter of the compaſs the ſhip ſails in, on which from the meridian ſet off 45 degrees for the SW. courſe, and draw the diſtance

 line,

line, and on it ſet off 54 leagues (four leagues being allowed for the back bearing of the Lizard) which is the ſhip's place at the end of her firſt courſe; from this place draw a new meridian parallel to the firſt, and again with the chord of 60 degrees deſcribe an arc in the quarter the ſhip ſails in, and make the centre the ſhip's place (when at the end of her firſt courſe) on which arc, from the new meridian ſet off 33° 45′ for the SW by S. courſe, and draw the diſtance line, and on it ſet off 42 leagues, and it will be the ſhip's place at the end of her ſecond courſe. Proceed to draw a new meridian as before, on which ſet off 45 leagues for the diſtance, as the ſhip ſailed due ſouth, it will be her place at the end of her third courſe; continue the ſouth line for a new meridian, and ſweep an arc (of 60 degrees from her place at the end of her third courſe) in the SW. quarter, and ſet off 22° 30′ for the SSW. courſe, then draw the diſtance line, and on it ſet off 56 leagues, and it will be the ſhip's place at the end of her fourth and laſt courſe. Now to find the bearing and diſtance of the lizard, draw a line from the Lizard to the ſhip's place, which will be the true diſtance from the Lizard, and the angle it makes will be the bearing.

Courſe corrected.	Points.	Diſt. in leagues.	Northing.	Southing.	Eaſting.	Weſting.
SW.	4	54	—	38.2	—	38.2
SWbyS.	3	42	—	34.9	—	23.3
South.	0	45	—	45.	—	—
SSW.	2	56	—	51.7	—	21.4
				169.8		82.9

	L.	
	169. 8	
	3	
	6,0)50,9. 4	
Dif. lat.	8. 29	S.
Lat. Liz.	49. 57	N.
Lat. in	41. 28	N.

	L.			L.
As diff. lat. 169 .8	= 7.77006	As f. cou. 26°.01	=	0.35790
·· radius 90°.	=10.	·· depart. 82 . 9	=	1.91855
:: depart. 82 .9	= 1.91855	:: radius 90°.	=	10.00000
·· tan. courfe 26°.01	= 9.68861	·· diftance 189	=	2.27645

A. The lizard bears N. 26°.01′ E. diftance 189 leagues, and the fhips is in the latitude of 41°.28′ N.

Exercifing Examples in Traverfe Sailing.

A fhip from latitude 24°.32′ N. fails on the following corrected courfes, viz. SW by W. 45 miles, ESE 50 miles, SW. 30 miles, and SE by E. 60 miles: What latitude is fhe arrived at, and what is her courfe and diftance made good?

Anf. Her latitude arrived at 22°.53′ N. her courfe S. 20°.49′ E. diftance 105.5 miles.

A fhip from latitude 36°.10′ N. fails on the following

courfes,

courses, (viz.) NNE. 6 miles, SE by S½E. 5 miles, NE by E½E. 4 miles, WNW½W. 8 miles, SW by S½W. 7 miles, NW by N. 4 miles, ENE. 5 miles, SW. 7 miles, and lastly SE by E. 5 miles: I demand her course and distance made good, as also the latitude arrived at?

Ans. Her course S. 33°41′W. or SW by S. distance 2.524 miles, and latitude arrived at 36°.08′N.

ON OBLIQUE SAILING.

Q. What is oblique sailing?

It is the doctrine of oblique trigonometry, applied to navigation and to the measuring of inaccessable objects.

EXAMPLE.

Two ships sailed from one port, one NW by N, 51′.2 miles, the other between the north and east, 94′.65 miles; when by observation they were in one latitude: What was the easternmost ship's course, and the distance of the ships?

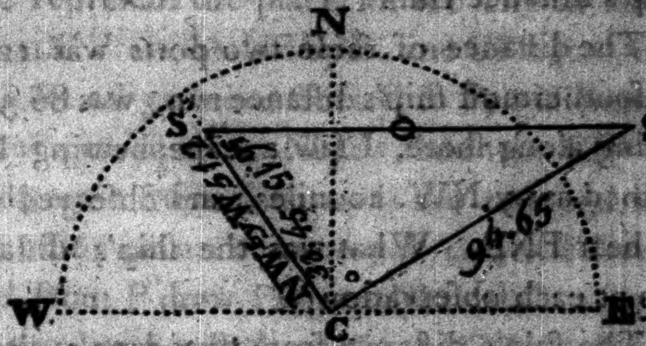
TO PROJECT the FIGURE.

RULE.

With a chord of 60 degrees, sweep the semi-circle WNE. let C represent the place from whence the ships sailed, then will NW be the north west, and NE be the north east quarters, in which the two ships sailed; from N towards W in the north west quarter, set off 33°.45′, which is the norther-most ship's course, draw the line C S, and on it, (from any scale of equal parts) set off 51′.2 miles from C to S her distance; then parallel

to

to W E draw S S and from C with 94.65 miles, from the same scale of equal parts used before cut SS at S in the north east quarter (the two ships being in one latitude) then is S S their true distance, and the angle N C S the easter-most ship's true course.



As Er. most ship's dist run 94′.65 = 8.02388
.. Wr. most ship's s. co. course 56°.15 = 9.91985
:: Wr. most ship's dist. run 51′. 2 = 1.70927

.. Er. most ship's s. co. course 26°.44 = 9.65300
90.

63 .16 Er. most ship's course.
33 .45

97 .01 The ∠ both ship's make.

As Wr. most ship's s. co. course 56°.15′ = 0.08015
.. Er. most ship's dist. run 94′.65 = 1.97612
:: S ∠ both the ships make 97°.01′ = 9.99673

.. Their distance 113 = 2.05300

Answer. The eastermost ship's true course, N 63°.16′ E and their true distance 113 miles.

 EXERCISING

Exercising Examples in Oblique Sailing.

Two ports ſituated due north and ſouth. A ſhip from the northermoſt ſailed SE. 68 miles; another from the ſouthermoſt ſailed NE by N. till the two ſhips meet: I demand the diſtance of theſe two ports, and the ſouthermoſt ſhip's diſtance run?

Anſ. The diſtance of theſe two ports was 120 miles; and the ſouthermoſt ſhip's diſtance run, was 86.55 miles.

Coaſting along ſhore, I ſaw a cape bearing NE by N. then I ſtood away NW. 20 miles, and obſerved the ſame cape to bear ENE. What was the ſhip's diſtance from the cape at each obſervation?

Anſ. The ſhip's diſtance from the cape at the firſt obſervation, was 33′.26 miles; and at the ſecond it was 35.31 miles.

ON PLYING to WINDWARD.

Q. What is meant by plying to windward?

A. It is, when a ſhip, veſſel, &c. ſails on various courſes, owing to contrary winds, by means of which the mariner is obliged to ſteer different ways to get to windward; and it is the application of oblique trigonometry.

EXAMPLE.

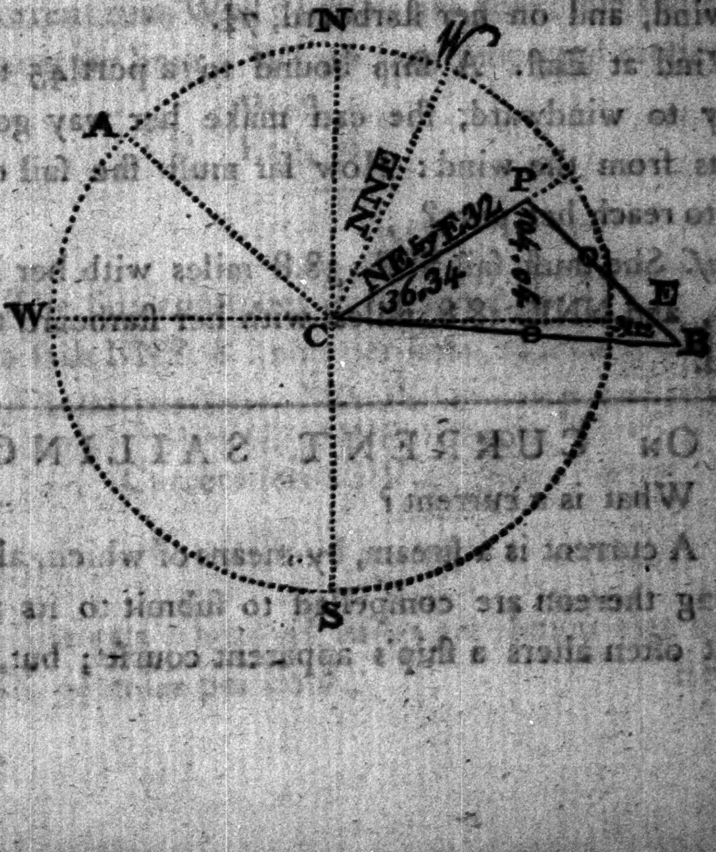
The wind at NNE. a ſhip is bound to a port bearing NE by E. diſtance 32 miles, propoſes to reach her port at two boards, but can lie no nearer the wind than 6¼ points: What's the diſtance ſailed on each courſe?

To

TO CONSTRUCT the FIGURE.

RULE.

With a chord of 60 degrees, ſweep the circle NESW, and let C repreſent the place for the ſhip in her firſt ſtation, from C draw the NE by E. line CP equal to 56°.15′ on which ſet off 32 miles from C to P, and from N to *W*, ſet off 22°.30′ equal to NNE. then will C*W* repreſent the wind; again from *W* towards the eaſt and weſt each way, ſet off 6¼ points equal to 70°.19′, and draw CA and CB, and from P draw PB parallel to AC. then will the ∠ C be equal to her firſt courſe and CB her firſt diſtance; alſo the ∠ B her ſecond courſe, and BP her ſecond diſtance.



As S∠B 39°.22′ = 0,19772	As S∠B 39°.22′ = 0.19772
. . CP 32′ = 1.50515	. . CP 32′ = 1.50515
: : S∠P 104°.04′ = 9.98678	: : S∠C 36°.34′ = 9.77507
. . CB 48.94 = 1.68965	. . BP 30′.06 = 1.47794

Anſ. She muſt ſail E. ½ South 48.94 miles with her larboard tacks on board, and NW½W. 30.06 miles with her ſtarboard tack.

Exerciſing Examples of Plying to Windward.

Wind at SWbyS. a ſhip diſcovers her port bearing WbyS. diſtance 15 miles, ſhe then hauled her wind and ſailed 33 miles on her larboard tack; then tacked and run 21 miles and arrived at her port: How near the wind did ſhe lie on each tack?

A. On her larboard tack ſhe ſailed within 6¾ points of the wind, and on her ſtarboard, 7½.

Wind at Eaſt. A ſhip bound to a port 45 miles directly to windward, ſhe can make her way good at 6 points from the wind: How far muſt ſhe ſail on each tack to reach her port?

Anſ. She muſt ſail SSE. 58.8 miles with her larboard tacks, and NNE. 58.8 miles with her ſtarboard tacks on board.

ON CURRENT SAILING.

Q. What is a current?

A. A current is a ſtream, by means of which, all bodies moving thereon are compelled to ſubmit to its motion, and it often alters a ſhip's apparent courſe; but, ſhould

a ſhip

a ship sail on a direct course with the setting of a current, it will accelerate her sailing by just so much as the drift of the current; or if she sails in a direct course opposite to the current's setting, it would retard her progress by just so much as the current's drift, without altering her course in either of the above cases. This sailing is the application or doctrine of plane triangles.

Q. How do you find the drift and setting of currents?

A. Take a boat at some little distance from the ship, and with a heavy iron pot, or loaded kettle, with a rope fastened to the boat's stern, let it sink into the sea, at 80, 90, or 100 fathoms deep, by which means the boat will ride almost as steady as at anchor; then heave the log and it will give the miles which the current sets per hour, and as the log bears it will shew the current's setting.

If a current runs West $6\frac{1}{2}$ miles per hour; and a ship sails E. $6\frac{1}{2}$ knots per hour: What's her compound motion?

West, 6.5
East, 6.5

..

Ans. The ship continues in the same place.

A ship sails NNE. 8 knots per hour, in a current setting SSW. $4\frac{1}{2}$ knots per hour: What's her compound motion?

Ship sails NNE. 8 knots.
Current sets SSW. $4\frac{1}{2}$

$3\frac{1}{2}$

Ans. She gets a head $3\frac{1}{2}$ miles per hour, that is, she sails NNE. $3\frac{1}{2}$ miles per hour.

EXAM.

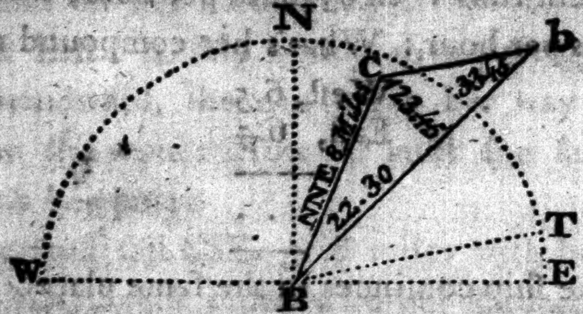
EXAMPLES.

A ship crossing the mouth of an haven, into which the tide sets EbyN. sails from a buoy bearing NNE. 8 miles and falls in with another buoy bearing NE. from the first: What's the drift of the current, and the distance of the buoys?

To Project the Figure.

RULE.

With a chord of 60 degrees sweep the circle WNE; let B represent the buoy sailed from, set off from N the ship's course NNE. equal to $22^\circ.30'$, and draw the line BC, equal to 8 miles; from N set off the two buoys bearing NE. equal to 45° and draw Bb, then from E set off EbyN. equal to $11^\circ.15'$ and draw BT, and parallel thereto, draw Cb and the figure is formed.



As S∠b = $33^\circ.45'$ = 0.25526		As S∠b $33^\circ.45'$ = 0.25526	
. . BC = $8'$ = 0.90309		. . BC $8'$ = 0.90309	
: : S∠B = $22^\circ.30'$ = 9.58284		: : S∠C $123^\circ.45'$ = 9.91985	
. . Cb = $5'.51$ = 0.74119		. . Bb 11.97′ = 1.07820	

Ans. The current's drift 5·51 miles; distance of the buoys 11.97 miles.

EXAM-

Exercising Examples in Current Sailing.

A ſhip from latitude 20°.13′ ſouth, ſails due eaſt 607 miles athwart a current ſetting north, when by obſervation ſhe was in latitude 15°.21 ſouth: How far did the current ſet her to the northward, and what was her rational courſe and diſtance?

A. The current ſet her 292 miles to the northward, and her rational courſe was Eaſt 25°.41′ north, diſtance 673.6 miles.

Suppoſe a ſhip ſails NbyE. 67 miles in a current that is known (in the ſame time) to ſet SSE. 36 miles: Required her rational courſe and diſtanee?

A. Her courſe NEbyN½E. nearly, diſtance 42.11 miles.

ON MERCATOR's SAILING.

Q. What is mercator's ſailing?

A. It is the application of rectangled trigonometry, with this obſervation, that the meridianal difference of latitude bears the ſame proportion to the difference of longitude, as the proper difference of latitude does to the departure; and that the angle made by the continuation of the diſtance till it cuts the difference of longitude, is equal to the complement of the courſe.

NAUTICAL OBSERVATIONS.

Q. Suppoſe you have the longitude of any two places given: How do you find their difference of longitude?

A. If

A. If the longitudes are of the ſame name, their difference is the difference of longitude required—but if of contrary names, their ſum will give the difference of longitude.

EXAMPLES.

What's the difference of longitude between the Lizard and Gibraltar?

Gibraltar's long.	5°.22′	W.
Lizard's long.	5 .15	W.
Anſ.	7	

What's the difference of longitude between Portſmouth and Minorca.

Portſmouth's long.	1°. 6′	W.
Minorca's long.	3 .49	E.
Anſ. Diff. of long.	4 .55 = 295 miles.	

Q. Suppoſe a ſhip ſails from any longitude, and makes difference of longitude: How do you find what longitude the ſhip is arrived at?

A. If the given longitude and difference of longitude are of one name, their ſum is the longitude of the ſame name—but ſhould the given longitude and difference of longitude be of contrary names, their difference will be the longitude required, of the ſame name as the greater.

EXAM-

EXAMPLES.

A ship from the Lizard sails westward till her difference of longitude is 350 miles: What longitude is she in?

Lizard's long. $= 5^\circ.15'$ W.
Diff. long. $350' \div 60 = 5\ .50$ W.

Ans. long. in $11\ .05$ W.

A ship from $1^\circ.30'$ East longitude sails westward till her difference of longitude is 210 miles: What longitude is she in?

Diff. long. $210' \div 60 = 3^\circ.30'$ W.
Long. sailed from $1\ .30$ E.

Ans. long. in $2\ .00$ W

Q. Suppose the sum of any two given longitudes to exceed 180 degrees either east or west: How do you find what longitude you are arrived at?

A. By subtracting such a sum from 360 degrees, and the remainder will be the longitude arrived at, of a contrary name.

EXAMPLE.

A ship from longitude $140^\circ.24'$ west sails westward until she differs her longitude $46^\circ.10'$ west: What longitude is she arrived at?

Long. left	140°.24′ W.
Diff. long.	46 .10 W.
	186 .34 W.
	360
Anſ. long. in	173 .26 E.

A ſhip from longitude 178°.59′ E. ſails eaſtward until her difference of longitude is 129 miles Eaſt: What is her longitude arrived at?

Long. from	178°.59′ E.
Diff. long. 129÷60=	2 .09 E.
	181 .08 E.
	360 .00
Anſ. long. arrived at	178 .52 W.

Q. What is the courſe and diſtance from the Lizard to Liſbon?

TO PROJECT THE FIGURE.

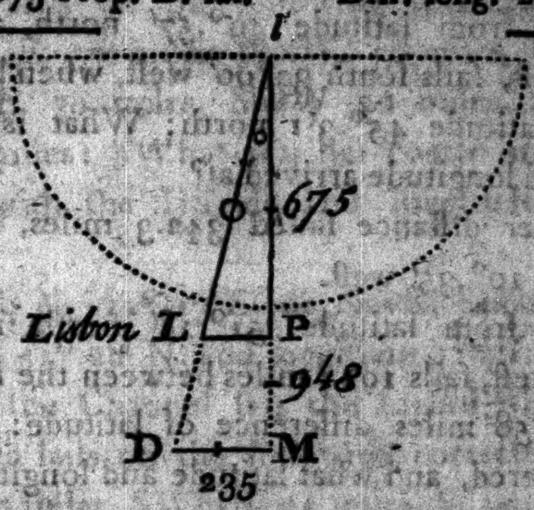
RULE.

Sweep the ſemi-circle, and let l repreſent the Lizard, from which draw the meridian, and on it (from any ſcale of equal parts) ſet off from l to M the meridional diff. of lat. 948 miles ſouth; from M, at right angles to l M, draw MD, and on it ſet off the difference of longitude 235 miles weſt from M to D; then draw the line l D; again from l to P, ſet off the proper difference of latitude 675

 miles,

miles, from which draw PL parallel to MD to cut lD, then will the angle made at l be the true course and $l$$L$ the true distance.

		M. Parts.		
Lizard's lat.—	49°.57′N.	—3470	Lizard's long.—	5°.15′W.
Lisbon's lat.—	38 ,42 N.	—2522	Lisbon's long.—	9 .10 W.
	11 .15	948 M. D. lat.		3 .55 W.
	60			60
	675 Prop. D. lat.		Diff. long.	235 W.



As Md. diff. lat.	—948′—	7.02319
: radius	—90°.—	10.
: : diff. long.	—235′—	2.37107
: tan. cou.	—13.55—	9.39426

As rad.	— 90° —	0.
: P. D. lat.	— 675′	2.82930
: : sec. cou.	—13.55 —	10.01294
Distance	—695.4 —	2.84224

 Ans.

Anſ. The courſe is S. 13°.55′ W. diſtance 695.4 miles.

Exerciſing Examples in Mercator's Sailing.

A ſhip from latitude 51°.18′ north, and longitude 9°.50′ weſt, ſails ſouth 33°.08′ weſt, till her diſtance run is 1024 miles: What is her latitude and longitude arrived at?

Anſ. Her latitude arrived at 37°.01′ north, and longitude 22°.56′ weſt.

A ſhip from latitude 49°.57′ north, and longitude 5°.14′ weſt, ſails ſouth 39°00′ weſt, when by obſervation ſhe is in latitude 45°.31 north: What is her diſtance ſailed, and longitude arrived at?

Anſ. Her diſtance ſailed 342.3 miles, and longitude arrived at 10°.35′ weſt.

A ſhip from latitude 51°.18′ north, and longitude 22°.56′ weſt, ſails 1024 miles between the ſouth and eaſt, making 858 miles difference of latitude: What is her courſe ſteered, and what latitude and longitude is ſhe now in?

Anſ. Her courſe ſouth 33°.05′ eaſt, latitude 37° north, and longitude 9°.51′ weſt.

A ſhip from latitude 50°.10′ ſouth, and longitude 10°.16′ eaſt, ſails ESE. until her departure be 957 miles: I demand the diſtance ſailed, and the latitude and longitude ſhe is now in?

Anſ. Diſtance ſailed 1036 miles, latitude in 56°.46′ ſouth, and longitude 37°.06′ eaſt.

A ſhip

A ſhip from latitude 50°.40′ north, longitude 25°.30′ weſt, ſails north 33°.07′ eaſt, till ſhe finds her difference of longitude to be 786 miles: What latitude and longitude is ſhe now in, and what diſtance has ſhe failed?

Anſ. Latitude 61°.44′ north, longitude 12°.24 weſt, and diſtance ſailed 792.8 miles.

A ſhip from latitude 49°.40′ north, and longitude 5°.20′ weſt ſails on the following corrected courſes, (viz.) NEbyN¼E. 56 miles, NNW. 38 miles, NWbyW. 46 miles, SSE. 30 miles, SbyW 20 miles, and laſtly, NEbyN. 60 miles: What was her courſe and diſtance made good, with the latitude and longitude ſhe arrived at?

Anſ. Courſe N. 11°.17′E. or NbyE. diſtance 110.5 miles, latitude 51°.28′ N. and longitude 4°.46′ W.

A ſhip in the Channel ſets the Lizard NE. diſtance 12 miles; then ſails on the following corrected courſes, (viz.) SW. 30 miles, SWbyS. 24 miles, S. 20 miles, and laſtly, SSW. 36 miles: What is the bearing and diſtance of the Lizard, and what latitude and longitude is the ſhip now in? The Lizard's latitude is 49°.57′N. and longitude 5°.15′ weſt.

Anſ. The Lizard bears north 28°.53′ eaſt, diſtance 117.6 miles, the latitude the ſhip is in, is 48°.14′ north, and longitude 6°.42′ weſt.

On MIDDLE LATITUDE SAILING.

Q. What is Middle Latitude Sailing?

A. It is so called from working from the middle of any two latitudes; and it is mostly used near the line or in low latitudes, but Mercator's chiefly every where else.

Q. When the bearings and distance of any two places are required, what is the proportion by Middle Latitude.

A. Thus,

As diff. lat. . . s. co. mid. lat. : : diff. long. . . tan. course or bearings	or thus,	As diff. lat. . . radius : : departure . . t. course or bearings

N. B. The distance is found by Plane Sailing, but the departure thus,

As radius
. . diff. long.
: : s. co. mid. lat.
. . departure

*** Lastly, to find the difference of longitude, it is thus,

As s. co. mid. lat. . . departure : : radius . . diff. long.	or thus,	As s. co. mid. lat. . . distance : : s. course . . diff. long.

Exam-

EXAMPLE.

What is the course and distance from the Lizard to Madeira?

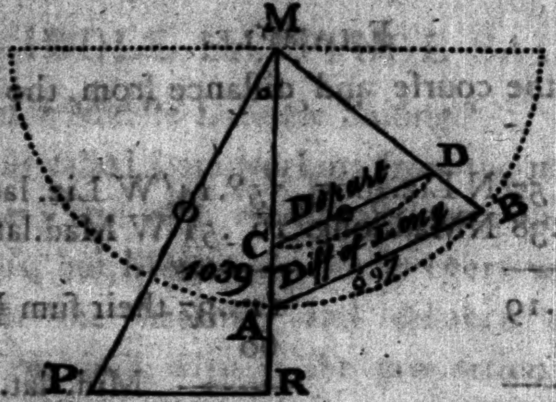
Liz. lat.	49°.57' N	Liz. long.	5°.14' W	Liz. lat.	49°.57' N
Mad.lat.	32 .38 N	Mad.long.	16 .51 W	Mad.lat.	32 .38 N
	17 .19		11 .37	their sum ½)	82 .35
	60		60		
				Mid. lat.	41 .17
Diff.lat.	1039 N	D. long.	697 W		90
				Comp. Mid. lat.	48 .43

TO PROJECT the FIGURE.

RULE.

Draw the meridian MR, and from M, with 90 degrees off the line of Sines sweep an arc, upon which set off from A to B 697 miles the difference of longitude; then draw MB again about M, with 48°.43' the co. middle latitude off the line of Sines, describe another arc, and the distance it measures from C to D, will be the departure; then from M, set off upon the meridian the difference of latitude (in like manner as in a Plane Sailing question) 1039 miles, and from R, (making a right angle at R,) set off the length CD, the departure from R to P and draw MP the distance line; then will the angle RMP be equal to the course, and MP the distance.

As



As diff. lat. $1039' = 6.98339$
. . s. co. mid. lat. $48^{\circ}.43' = 9.87590$
: : diff. long. $697' = 2.84323$

. . t. course $26^{\circ}.45' = 9.70252$

As radius $90^{\circ} = 0.$
. . diff. lat. $1039' = 3.01661$
: : sec. course $26^{\circ}.45' = 10.04916$

. . distance $1164 = 3.06577$

Ans. The course is south $26^{\circ}.45'$ west, distance 1164 miles.

EXERCISING EXAMPLES in MIDDLE LATITUDE SAILING.

A ship from latitude 37° north, and longitude $22^{\circ}.56'$ west, sails north $33^{\circ}.19'$ east, till by observation she was in latitude $51^{\circ}.18'$ north: What is her distance run, and longitude in?

Ans. Distance run 1027 miles, longitude in $9^{\circ}.50'$ west.

A ship from the latitude $49^{\circ}.30'$ north, and longitude $5^{\circ}.15'$ west, sails south $33^{\circ}.19'$ west, till her distance

run

run is 1027 miles: What is her latitude and longitude come to?

Anſ. Latitude come to 35°.12′ north, and longitude 17°.57′ weſt.

A ſhip in latitude 51°.18′ north, and longitude 22°.56′ weſt, is bound to a place which lies in the SE. quarter, diſtance 1027 miles, whoſe latitude is 37° north: What courſe muſt ſhe ſteer, and what longitude is her intended port in?

Anſ. She muſt ſteer ſouth 33°.20′ eaſt, or SEbyS. and her intended port's longitude is 9°.50′ weſt.

A ſhip from latitude 37° north, and longitude 30°.30′ weſt, ſails between the north and eaſt till by obſervation ſhe comes to latitude 51°.18′ north, and then finds ſhe has made 564 miles departure: What is her courſe and diſtance made good, with the longitude arrived at?

Anſ. Courſe made good north 33°.19′E. or NEbyN: diſtance 1027 miles, longitude arrived at 17°.42′ weſt.

A ſhip from latitude 51°.18′ north, and longitude 30°.30′ weſt, ſails ſouth 33°19′ weſt, till her departure is 564 miles: Required her preſent latitude and longitude, alſo the diſtance ſhe ſailed?

Anſ. Her latitude 37° north, and longitude 43°.36′ weſt, and diſtance ſailed 1027 miles.

A ſhip from latitude 37° north, and longitude 43°.36′ weſt, ſails between the north and weſt 1027 miles.

miles, and then found her departure to be 564 miles: Required her course, with latitude and longitude come to?

Anʃ. Courſe north 33°.19′ weſt, or NWbyN. latitude come to 51°.18′ north, and longitude 56°.42′ weſt.

On the Principal ANGLES and ARCS of CIRCLES relative to NAVIGATION.

Q. What is the altitude of the ſun, moon, or ſtar?

A. It is an arc of the azimuth circle between it's centre and the horizon?

Q. What is zenith diſtance?

A. It is the co-altitude, viz. the arc of the azimuth circle between the object's centre and the zenith.

Q. What do you mean by meridian altitude?

A. It is when the object is on the meridian, and is at it's greateſt height for that day.

Q. What is an amplitude?

A. An arc of the horizon contained between the object's centre and the eaſt at it's riſing, and weſt at it's ſetting?

Q. What is an azimuth?

A. An arc of the horizon between the meridian of the place and the azimuth circle, paſſing through the object's centre, or it is it's diſtance from the north and ſouth points of the compaſs.

Q. What is declination?

A. It is an arc of the meridian between the equator and centre of the object, and when on the north ſide of the equator,

equator it is north declination; but when on the south side, it is south declination.

Q. What is refraction?

A. The difference between the true and apparent altitude of objects.

On the VARIATION of the COMPASS.

Q. What is the variation of the compass?

A. An arc of the horizon contained between the meridian of the place and the magnetic meridian, and whenever the needle does not point directly to the north point of the heavens, that difference is called the variation of the compass, which is always east or west.

Q. How do you find the variation of the compass?

A. By an amplitude or azimuth.

Q. What do you mean by the sun's true amplitude?

A. It is an arc of the horizon contained between the true east or west points of the heavens, and the sun's centre at his rising or setting.

Q. What is magnetic amplitude?

A. It is the number of degrees and minutes that the sun's centre is to the northward or southward of the east or west points of the compass, at his rising or setting; which is generally taken with an azimuth compass.

Q. What must be given to find the variation of the compass by an amplitude?

A. The latitude of the place, the declination of the object, and the magnetic amplitude?

Q. What

Q. What is the proportion for finding the true amplitude?

A. As sine complement of the latitude, is to radius; so is the sine of the object's declination, to sine of the true amplitude.

EXAMPLE.

At sea, latitude 63°.30′ north, sun's declination 11°.13′ south, the sun rose to the southward of the east: What was the true amplitude?

As s. co. lat.	= 26°.30′ =	0.35047
.. radius -	= 90°. =	10.
.. s. sun's dec.	= 11°.13′ =	9.28896
.. s. true amp.	= 25°.51′ =	9.63943

Ans. The true amplitude was E. 25°.51′ S.

Q. Having found the true amplitude, how do you proceed to find the variation of the compass?

A. When the amplitudes have one name, that is, both north or south, and they agree, there is no varirtion; but should they disagree, their difference is the variation.

Q. But suppose the amplitudes have contrary names, that is, one north, and the other south: How is the variation then found?

A. Their sum is the variation.

Q. How do you know when the variation is east or west?

A. Look towards the sun, and if the true amplitude be to the right-hand of the magnetic, the variation is east, but when to the left-hand, it is west.

Q. How

Q. How do you know whether the true amplitude be to the northward or ſouthward of the eaſt or weſt?

A. If taken in the morning, it is eaſt ſo much north, or eaſt ſo much ſouth, according to the declination; but in the afternoon, weſt ſo much north or ſouth, as the declination may be north or ſouth.

ON AMPLITUDES.

Q. How are figures in amplitudes projected orthographically?

N.B. In the projections you uſe only the line of chords.

A. 1ſt. Deſcribe a circle of 60 degrees, and quarter it, place NS and EW always as per figure, and A at the centre of the circle, then will N repreſent the north, S the ſouth, E the eaſt, W the weſt, and SAN the horizon.

2d. Set off the latitude (if north) from N to P towards W, but if ſouth, from S to I towards W, and draw the axis PAI or IAP, then at right angles to PAI or IAP, draw ÆAQ the equator.

3d. Set of the ſun's declination on the primitive circle from the equator towards north, if north declination; and towards ſouth, when ſouth declination: and draw the parallel of declination parallel to it, to cut the horizon SAN in C, theplace of the ſun's riſing or ſetting.

4th. Meaſure AC on the line of ſines, it is the ſun's true amplitude north, if the declination be north; but ſouth, when the declination is ſouth.

5th. Draw C-a parallel to WAE towards the east when it is AM. but towards the west if PM. to cut the primitive in a.

6th. Set off the Mag-amp. if $\left\{\begin{array}{c}\text{AM}\\ \text{PM}\end{array}\right\}$ from $\left\{\begin{array}{c}\text{E}\\ \text{W}\end{array}\right\}$ towards N when north, but towards S when it is south.

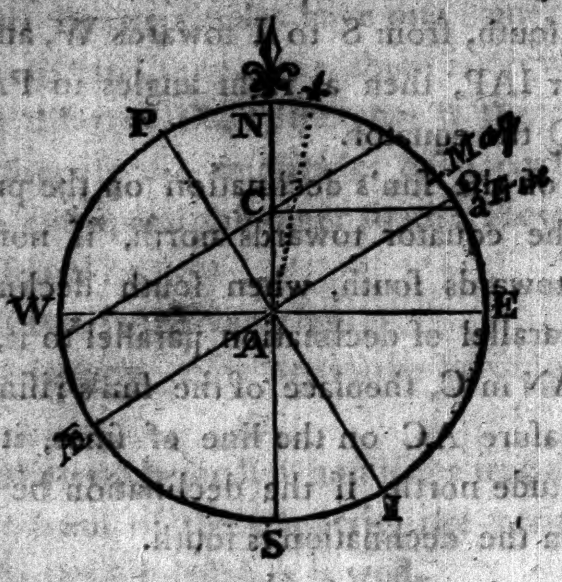
7th. The distance between the mag. and the true amplitudes set off from N towards W, when west variation, and towards E, when east variation, will give the false nort, and the whole figure finished. The distance from N to false north, measured on the scale of chords, is the variation of the compass.

CASE I.

When the amplitudes have one name.

EXAMPLE.

At sea in latitude 30° north, sun's declination being 23°.10′ north, the sun rose 36°.30′ to the northward of the east: What was the variation of the compass?



As ſ. co. lat. =60°.00= 0.06247	Mag. amp. E. 36°.30′ N
.. radius =90 .00=10.	True amp. E. 27 .13N.
: : ſ. ſun's dec.=23 .20= 9.59778	
	Variation 9 .17 E.
.. ſ. true amp.=27 .13= 9.66025	

Anſ. Variation 9°.17′ Eaſt.

Exercising Examples under Case I.

Being at ſea in latitude 20° ſouth, ſun's declination 19° ſouth, the ſun ſet 10° to the ſouthward of the weſt: What was the variation?

Anſ. 10°.16′ weſt.

At ſea, latitude 50° ſouth, ſun's declination 20° north, the ſun ſet weſt 19° north: What was the variation?

Anſ. 13°.09′ eaſt.

At ſea, latitude 63°.30′ north, ſun's declination 11°.13′ ſouth, the ſun roſe eaſt 37°.30′ ſouth: What was the variation of the compaſs?

Anſ. 11°.39′ weſt.

At ſea, the Lizard bore NNE. diſtance 9 miles when the ſun's declination was 20°.28′ north, we obſerved the ſun to riſe eaſt 17°.46′ north: What was the variation of the compaſs?

Anſ. 18°.34′ weſt.

CASE II.

When the amplitudes have different names.

EXAMPLE.

Being at ſea in the latitude of 28°.30′ north, ſun's declination 11°.13′ ſouth, the ſun roſe eaſt 3°.20′ north: What was the variation of the compaſs?

As ſ. co. lat.	= 61°.30 =	0.05610
: radius	= 90 .00 =	10.00000
: : ſ. declin.	= 11 .13 =	9.28896
∴ ſ. true amp.	= 12 .48 =	9.34506

Mag. amp. E. 3. 20 S.

16 .08

Anſ. Variation 16°.08′ Eaſt.

EXERCISING EXAMPLES under CASE II.

Being at ſea, latitude 40° ſouth, ſun's declination 4°.43′ north, the ſun roſe eaſt 2°.30′ ſouth: What was the variation?

Anſ. Variation 8°.40′ weſt.

At ſea, latitude 35° north, ſun's declination 10° ſouth, the ſun ſet WbyN. What was the variation?

Anſ. Variation 23°.29′ weſt.

At ſea, latitude 50°.10′ north, ſun's declination 6°.20′ north, the ſun ſet 2° to the ſouthward of the weſt: What was the variation?

Anſ. Variation 11°.55′ eaſt.

On AZIMUTHS.

Q. What muſt be given to find the true azimuth?

A. The latitude of the place, the object's declination, and its altitude?

Q. What is the proportion for working an azimuth?

A. Add the complement of the latitude, the complement of the altitude, and the ſun's diſtance from the pole, together; from half that ſum take the ſun's diſtance from the pole, and note the remainder, then add the arithmetical complement of the co. ſine of the latitude, the arithmetical complement of the co. ſine of the altitude, the ſine of half the ſum, and the ſine of the remainder, together, the half ſum thereof is the co. ſine of half the azimuth; double it, and reckon from the north in north latitude, and from the ſouth in ſouth latitude.

N. B. When the latitude and declination have one name, ſubtract the declination from 90°; the remainder is the ſun's diſtance from the pole; but when of different names, add the declination to 90° gives the ſun's diſtance from the pole.

EXAMPLE.

At ſea, in the latitude of 48°.56′ north, ſun's declination 20°.16′ north, his altitude in the afternoon was obſerved to be 58°.30′: What was his azimuth?

90°.00'		90°.00'	
38 .30	altitude	20 .16	declination ☉
51 .30	co. altitude	69 .44	sun's dist. from the pole.

90°.00	
48 .56	latitude
41 .04	co. lat.
51 .30	co. alt.
69 .44	dist. from the pole
½)162 .18	their sum
81 .09	their ½ sum
69 .44	sun's dist. from the pole
11 .25	the remainder

Co. s. lat. 9.81752	its arith. comp.		= 0.18248
Co. s. alt. 9.89354	its ditto -		= 0.10646
S. ½ sum - -		81°.09'	= 9.99480
S. of remainder -		11 .25	= 9.29654
			½)19.58028
Co. sine		51°.55'	= 9.79014
		2	
		103 .50	

Ans. 103°.50' from the north.

Q. What must be given to find the variation of the compass by an azimuth?

A. The latitude of the place, the object's declination, its altitude, and magnetic azimuth.

Q. What

Q. What is magnetic azimuth?

A. An arc of the horizon contained between the ſun's azimuth circle and the magnetic meridian; or it is the apparent diſtance that an object (when obſerved) is from the north or ſouth points of the compaſs, either in the forenoon or afternoon.

Q. Knowing how to find the true azimuth, how do you proceed to find the variation?

A. Comparing the azimuths in the morning, counting from the *North*, if the true exceeds the magnetic, their difference is the variation *Eaſt*: but if the magnetic exceeds the true, the difference is the variation *Weſt*. In the afternoon, the contrary, or placing both the azimuths (before your face) from you, if the true azimuth be to the right hand of the magnetic, the variation is *Eaſt*; but if to the left-hand, the variation is *Weſt*.

Q. How are figures in azimuths projected orthographically?

N. B. In the projections you uſe only the line of chords.

A. 1ſt. Deſcribe a circle and quarter it, lay off the latitude, draw the equinoctial axis, and parallel of declination in all reſpects as directed in amplitudes.

Set off the ſun's altitude on the primitive circle from the horizon SAN towards W, and draw the parallel of altitude parallel to SAN, to cut the parallel of the ſun's declination in C, the place of the ſun at that time.

3d. Draw

3d. Draw CO parallel to WAE towards the east when it is AM. but towards the west if PM. till it meets an arc made (with FG half the length of the parallel of altitude) from the centre of the primitive circle, as A.

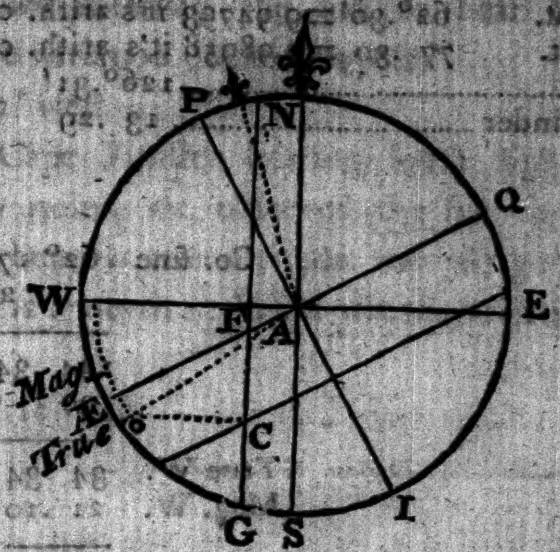
4th. From A through O draw a line to cut the primitive circle, which place will give the true azimuth; it measured on the line of chords to N or S, sheweth the sun's true azimuth.

5th. Lay off the mag. azimuth if north latitude from the north; but if south latitude, from the south towards $\left\{ \begin{matrix} \text{E} \\ \text{W} \end{matrix} \right\}$ when it is $\left\{ \begin{matrix} \text{AM.} \\ \text{PM.} \end{matrix} \right\}$ to the mag. azimuth on the primitive circle.

6th. The distance between the mag. and true amplitude set off from N towards W when west variation, and towards E when east variation, will give the false north, then the whole figure is finished, and the distance from N to the false north measured, on the scale of chords, is the variation of the compass.

EXAMPLE.

Being at sea in the latitude of 27°.30′ north, when the sun's declination was 23°.01′ south, we observed his true altitude in the afternoon to be 12°.30′, and the magnetic azimuth west 21°.10′ south: What was the variation of the compass?



90°		90°	
12 .30		23 .01 south	
77 .30 co. alt.		113 .01 sun's dist. from the pole.	

90°
27 .30 latitude

62 .30 co. latitude
77 .30 co. altitude
113 .01 sun's dist. from the pole

$\frac{1}{2}$)253 .01 sum

126 .30 their $\frac{1}{2}$ sum
113 .01 sun's dist. from the pole

13 .29 the remainder.

Co

Co. f. of lat.	62°.30′	=9.94793 it's arith. co.		=0.05207
Co. f. of alt.	77 .30	=9.98958 it's arith. co.		=0.01042
S. ½ fum			126°.31′	=9.90509
S. of remainder			13 .29	=9.36766
				½)19.33524
		Co. fine	62°.17′	= 9.66762
			2	
			124 .34	
			90	
		True W.	34 .34 S.	
		Mag. W.	21 .10 S.	
		Variation	13 .24 weft.	

Anf. Variation 13°.24′ weft.

Exercifing Examples in finding the Variation by an Azimuth.

Being at fea, in latitude 37°.10′ fouth, when the fun's declination was 22°.50′ north, and his true altitude 12°.16′, he then bearing per compafs eaft 47°.19′ north: What was the variation of the compafs?

Anf. 5°.38′ eaft variation.

Being at fea, in latitude 47°.39′ north, when the fun's declination was 21°.06′ north, we obferved his true altitude to be 16°.35′, he then bearing weft 2°.02′ fouth: What was the variation of the compafs?

Anf. 15°.22′ eaft.

At fea, in latitude 28°.40′ north, the fun's true altitude was 20°.19′, and declination 19°.12′ fouth, at which

which time we obſerved the ſun to bear SWbyW. What was the variation of the compaſs?

Anſ. 3°.17′ weſt.

At ſea, Cape Finiſter bearing ſouth 65°.09′ eaſt, diſtance 169 miles, we obſerved the ſun to bear eaſt 22° ſouth, when his true altitude was 36°.30′; and declination 23°.21′ north: What was the variation of the compaſs?

Anſ. 20°.18′ eaſt.

TABLE I.

The REFRACTIONS of the HEAVENLY BODIES in ALTITUDE.

App. Alt.	Refrac.	App. Alt.	Refrac.	App. Alt.	Refrac.
D. M.	M. S.	D. M.	M. S.	D. M.	M. S.
0. 0	33. 0	2.30	16.24	6.30	7.51
0. 5	32.10	2.35	16. 4	6.40	7.40
0.10	31.22	2.40	15.45	6.50	7.30
0.15	30.35	2.45	15.27	7. 0	7.20
0.20	29.50	2.50	15. 9	7.10	7.11
0.25	29. 6	2.55	14.52	7.20	7. 2
0.30	28.22	3. 0	14.36	7.30	6.53
0.35	27.41	3. 5	14.20	7.40	6.45
0.40	27. 0	3.10	14. 4	7.50	6.37
0.45	26.20	3.15	13.49	8. 0	6.29
0.50	25.42	3.20	13.34	8.10	6.22
0.55	25. 5	3.25	13.20	8.20	6.15
1. 0	24.29	3.30	13. 6	8.30	6. 8
1. 5	23.54	3.40	12.40	8.40	6. 1
1.10	23.20	3.50	12.15	8.50	5.55
1.15	22 47	4. 0	11.51	9. 0	5.48
1.20	22.15	4.10	11.29	9.10	5.42
1.25	21.44	4.20	11. 8	9.20	5.36
1.30	21.15	4.30	10.48	9.30	5.31
1.35	20.46	4.40	10.29	9.40	5.25
1.40	20.18	4.50	10.11	9.50	5.20
1.45	19.51	5. 0	9.54	10. 0	5.15
1.50	19.25	5.10	9.38	10.15	5. 7
1.55	19. 0	5.20	9.23	10.30	5. 0
2. 0	18.35	5.30	9. 8	10.45	4.53
2. 5	18.11	5.40	8.54	11. 0	4.47
2.10	17.48	5.50	8.41	11.15	4.40
2.15	17.26	6. 0	8.28	11.30	4.34
2.20	17. 4	6.10	8.15	11.45	4.29
2.25	16.44	6.20	8. 3	12. 0	4.23

App. Alt.	Refrac.	App. Alt.	Refrac.	App. Alt.	Refrac.
D. M.	M. S.	D.	M. S.	D.	M. S.
12.20	4.16	30	1.38	60	0.33
12.40	4. 9	31	1.35	61	0.32
13. 0	4. 3	32	1.31	62	0.30
13.20	3.57	33	1.28	63	0.29
13.40	3.51	34	1.24	64	0.28
14. 0	3.45	35	1.21	65	0.26
14.20	3.40	36	1.18	66	0.25
14.40	3.35	37	1.16	67	0.24
15. 0	3.30	38	1.13	68	0.23
15.30	3.24	39	1.10	69	0.22
16. 0	3.17	40	1. 8	70	0.21
16.30	3.10	41	1. 5	71	0.19
17. 0	3. 4	42	1. 3	72	0.18
17.30	2.59	43	1. 1	73	0.17
18. 0	2.54	44	0.59	74	0.16
18.30	2.49	45	0.57	75	0.15
19. 0	2.44	46	0.55	76	0.14
19.30	2.39	47	0.53	77	0.13
20. 0	2.35	48	0.51	78	0.12
20.30	2.31	49	0.49	79	0.11
21. 0	2.27	50	0.48	80	0.10
21.30	2.24	51	0.46	81	0. 9
22. 0	2.20	52	0.44	82	0. 8
23. 0	2.14	53	0.43	83	0. 7
24. 0	2. 7	54	0.41	84	0. 6
25. 0	2. 2	55	0.40	85	0. 5
26. 0	1.56	56	0.38	86	0. 4
27. 0	1.51	57	0.37	87	0. 3
28. 0	1.47	58	0.35	88	0. 2
29. 0	1.42	59	0.34	89	0. 1

TABLE II.

Depression or Dip of the Horizon of the Sea.

Height of the Eye.	Dip of the Horizon.
Feet.	M. S.
1	0.57
2	1.21
3	1.39
4	1.55
5	2. 8
6	2.20
7	2.31
8	2.42
9	2.52
10	3. 1
11	3.10
12	3.18
13	3.26
14	3.34
15	3.42
16	3.49
17	3.56
18	4. 3
19	4.10
20	4.16
21	4.22
22	4.28
23	4.34
24	4.40
26	4.52
28	5. 3
30	5.14
35	5.39
40	6. 2
45	6.24
50	6.44
60	7.23
70	7.59
80	8.32
90	9. 3
100	9.33

TABLE III.

The Sun's Parallax in Altitude.

Sun's Alt.	Sun's Parallax.
D.	S.
0	9
10	9
20	8
30	8
40	7
50	6
55	5
60	4
65	4
70	3
75	2
80	2
85	1
90	0

TABLE IV.

Augmentation of the Moon's Semi-diameter.

Moon's Alt.	Augmentation.
D.	S.
0	0
5	1
10	3
15	4
20	6
25	7
30	8
35	9
40	10
45	11
50	12
55	13
60	14
70	15
80 &c.	16

On finding the APPARENT and TRUE ALTITUDES of the SUN and MOON's CENTRES; also the APPARENT and TRUE ALTITUDE of a FIXT STAR, with the APPARENT DISTANCE of the SUN and MOON's CENTRES, by OBSERVATIONS taken at Sea.

Q. How do you find the apparent altitude of the sun's centre?

A. If I observe his upper limb, subtract the sum of his semi-diameter and dip; but if his lower limb be observed, add the semi-diameter and subtract the dip from the observed altitude.

EXAMPLES.

At sea the 1st of April, 1783, I observed the meridian altitude of the sun's upper limb to be 68°.40': What was his apparent altitude when corrected?—the height of the observer's eye was 18 feet above the surface.

Sun's semi-diam.	16'.02"	Obs. alt. sun's UL.	68°.40'.00"
Dip of horizon	4.03	—	20.05
Sum	20.05	App. alt.	68.19.55

Ans. 68°.19'.55" apparent altitude.

At sea the 1st of May, 1783, I observed the meridian altitude of the sun's lower limb to be 54°.30'.30": What was his apparent altitude when corrected?—The observer's eye was 21 feet above the surface.

Obſ. alt. ſun's L.L.	=	54°.30′.30″
Sun's ſemi-diam.	= +	15 .54
		54 .46 .24
Dip of horizon	= −	4 .22
App. alt. -	-	54 .42 .02

Anſ. 54°.42′.02″ apparent altitude.

Q. How is the true altitude of the ſun's centre found?

A. From the obſerved altitude ſubtract the refraction and dip, then add the parallax in altitude and ſemi-diameter when the lower limb is obſerved; but if the upper limb was obſerved, ſubtract the refraction, dip of horizon, and ſemi-diam. and add the parallax in altitude.

EXAMPLES.

At ſea the 1ſt of May, 1783, I obſerved the meridian altitude of the ſun's lower limb to be 57°.30′.30″: What was his true altitude?—The obſerver's eye was 21 feet above the ſurface.

Refraction	0′.36″	Parallax in alt.	0′.05″
Dip of hor.	4 .22	Semi-diameter	15 .54
	4 .58		15 .59

Obſ. alt. ſun's L.L.	57°.30′.30″
	−0 . 4 .58
	57 .25 .32
	+0 .15 .59
True altitude	57 .41 .31

Anſ. 57°.41.′31″ true altitude.

At

At sea the 1st of April, 1783, I observed the meridian altitude of the sun's upper limb to be 68°.40′: What was his true altitude?—The height of the observer's eye was 18 feet above the surface.

Refraction	0′.22″	Obs. alt. sun's UL.	68°.40′.00″
Dip of hor.	4 .03		—0 .20 .27
Semi-diam.	16 .02		
			68 .19 .33
Sum -	20 .27	Parallax in alt.	+0 .00 .03
		True alt. -	68 .19 .36

Ans. 68°.19′.36″ true altitude.

Q. How do you find the apparent altitude of the moon's centre?

A. To the observed altitude, add the sum of her semi-diameter and augmentation (when her lower limb is observed) and subtract the dip of the horizon; but should her upper limb be observed, subtract the sum of her semi-diameter, augmentation, and dip of horizon, from the observed alt. the remainder will be her apparent altitude.

EXAMPLES.

At sea the 5th of May, 1783, at midnight, I observed the altitude of the moon's lower limb to be 50°.30′.20″: What was her apparent altitude when corrected?—The height of the observer's eye was 18 feet above the surface.

 50°

50°.30′.20″	obs. alt. moon's LL.
+0 .14 .46	moon's semi-diameter.
+0 .00 .12	moon's augmentation.
50 .45 .18	
−0 .04 .03	dip of horizon.
50°.41 .15	app. altitude.

Ans. 50°41′.15″ apparent altitude.

At sea the 10th of May, 1783, near midnight, I observed the altitude of the moon's upper limb to be 37°.15′.30″: What was her apparent altitude when corrected?—The observer's eye was 30 feet above the surface.

15′.21″	semi-diam.	37 .15′.30″	moon's obs. alt. UL.
0 .09	augmentat.	−0 .20 .44	
5 .14	dip of hor.		
		36 .54 .46	app. altitude.
20 .44	sum.		

Ans. 36°.54′46″ app. altitude.

Q. How is the true altitude of the moon's centre found?

A. First find her apparent altitude, to which add the correction for reducing the apparent altitude, and it will give the true altitude required.

EXAMPLE.

At sea the 5th of May, 1783, at midnight, I observed the altitude of the moon's lower limb to be 50°.30′.20″: What was her true altitude?—Her horizontal parallax was

was 54'.12". and the height of the observer's eye was 18 feet above the surface.

TABLE VIII. Requisite Tables.

For alt. 50° and hor. par. 54'.12"	it is 31'.08"	—	31'.08"
For alt. 51 and hor. par. 54 .12	it is 30 .23		—0 .31
Difference for 1 degree in alt. -	00 .45		30 .37

If 1° ——45"——41'.15"

60	60
60	2475
60	45
3600	12375
	9900

3600) 111375 (31" nearly.
10800

3375

50°.41'.15" app. alt. found 2d Exam. back
+0 .30 .37 true cor. for 50°.41'.15" and HP 54'.12"

Ans. 51.11.52 the moon's true altitude.

Q. How do you find the apparent altitude of a fix'd star?

A. Subtract the dip of horizon from the observed altitude, the remainder will be equal to the apparent altitude required.

EXAMPLE.

EXAMPLE.

At sea I observed the altitude of the star Spica to be 47°.45': What was its apparent altitude when corrected? —The observer's eye was 18 feet above the surface?

Spica's obs. alt.	47°.45'.00"
Dip of horizon	—0 .04 .03
	47 .40 .57

Ans. 47°.40'.57" apparent altitude.

Q. How is the true altitude of a fixed star found?

A. Subtract the sum of dip of horizon and refraction from the observed altitude, the remainder will be the true altitude required.

EXAMPLE.

At sea, I observed the altitude of the star Regulus to be 50°.39'.40": What was its true altitude?—The height of the observer's eye was 21 feet above the surface.

4'.22"	dip of hor.	50°.39'.40"	Regulus's obs. alt.
0 .47	refraction	—0 .05 .09	dip of h. and refrac.
5 .09		50 .34 .31	true alt.

Ans. 50°.34'.31" true altitude.

Q. How do you find the apparent distance of the sun and moon's centres?

A. When their nearest limbs are observed, to the observed distance add the sum of their true semi-diameters; but

but should the sun's farthest limb and the moon's nearest limb be observed, subtract the sun's true semi-diameter and add the moon's.

EXAMPLES.

The 1st of April, 1783, at noon, I observed the distance of the sun and moon's nearest limbs to be 50°.17′.30″, when the altitude of the moon's lower limb was 42°.13′: What was the apparent distance of their centres?

The sun's true semi-diam. 16′.02″
The moon's semi-diameter 15 .23 } the moon's true semi-
The moon's augmentation 0 .10 } diameter.

Sum 31 .35

Sun and moon's nearest limbs observed 50°.17′.30″
+0 .31 .35

50 .49 .05

Ans. 50°.49′.05″ apparent distance.

The 1st of May, 1783, at noon, I observed the distance of the sun's farthest, and moon's nearest limbs to be 101°.30′.30″, when the altitude of the moon's upper limb was 36°.30′: What was the apparent distance of their centres?

The moon's semi-diam. 15′.1″
The moon's augmentation +0 .9

The moon's true semi-diam. 15 .10

The

The sun and moon's limbs, as before observed	101°.30′.30″
The sun's true semi-diam.	−15 .55
	101 .14 .35
The moon's true semi-diam.	+15 .10
Ans. The app. dist. of the sun and moon's centres.	101 .29 .45

On finding the LATITUDE by an OBSERVATION at NOON, or when the object is on your MERIDIAN.

N. B. In finding the latitude, you may count the sun's semi-diameter, at all times, 16 minutes, which will be found true enough; but in finding the longitude, it is necessary to make use of the nautical almanac, for the sun and moon's true semi-diameters.

C A S E I.

Q. When the sun or star has no declination, how is the latitude found?

A. The meridian zenith distance, is equal to the latitude of the place, of a contrary name to the zenith distance.

Q. How do you find the zenith distance?

A. By subtracting the true altitude from 90 degrees.

E X A M P L E.

At sea, I observed the altitude of the sun's lower limb to be 48°.10′ south of me, when his declination was nothing, and the observer's eye was 20 feet above the surface: What was the latitude?

4′.16″	dip for 20 feet	48°.10′	observed alt.
0.51	refract. for 48°	—5	dip and refraction.
5.07		48 .05	
		+16	sun's semi-diam.
		48 .21	true altitude
		90 .00	
		41 .39	zenith dist. south
		00 .00	declination.
	Ans.	41 .39	north latitude

CASE II.

Q. If the sun or star be in the zenith, how is the latitude found?

A. Then the declination is equal to the latitude of the same name as the declination.

EXAMPLE.

At sea, the 1st of August, 1783, I observed the sun to be in the zenith: What was the latitude?

Declination for 1st of August, 1783. } 18°.02′ north.

Ans. 18°.02′ north latitude.

CASE III.

Q. When the sun or star has declination and zenith distance, and both of the same name, how is the latitude found?

A. Their

A. Their difference will be the latitude of a contrary name, if the zenith distance is greatest; but when less, their difference is the latitude of the same name.

EXAMPLES.

At sea, the 1st of August, 1783, I observed the sun's lower limb to be 50° 30′ north of me, the observer's eye was 20 feet above the surface: What was the latitude?

	50° 30′	obs. alt.
0′.47″ refraction,	—5	dip and refraction
4 .16 dip		
5 .03	50 .25	
	+ 16	sun's semi-diameter.
	50 .41	true altitude.
	90 .00	
	39 .19	zenith dist. north.
	18 .02	declination north.
	Ans. 21 .17	latitude south

At sea, I observed the altitude of the sun's upper limb to be 85°.20′ north of me, when his declination was 23°.26′ north, the observer's eye being 22 feet above the surface: What was the latitude?

4′.28″ dip

4′.28″	dip	85°.20′	obſerver's altitude
0 .05	refraction	—21	ſemi-diam. dip. and refr.
16 . 0	ſun's ſemi-diam.		
		84 .59	true altitude
20 .33		90	
		5 .01	zenith diſt. north
		23 .26	declination north
		Anſ. 18 .25	north latitude

CASE IV.

Q. When the meridian zenith diſtance and declination of any object have contrary names, how is the latitude found?

A. The ſum of the meridian zenith diſtance and declination; is the latitude of the ſame name as the declination.

EXAMPLE.

At ſea, the 1ſt of Auguſt, 1782, I obſerved the ſun's lower limb to be 61°.48′ ſouth of me, when the obſerver's eye was 24 feet above the ſurface: What was the latitude?

4′.40″	dip	61°.48	obſerved altitude
0 .30	refraction	—5	dip and refraction
5 .10		61 .43	
		+16	ſun's ſemi-diam.
		61 .59	true altitude
		90 .00	
		28. 01	zenith diſtance ſouth
		17 .58	declination north
		Anſ. 45 .59	north latitude

N. B. In many parts of the world the ſun does not ſet for days together, and many ſtars never ſet, but tranſit the meridian below the pole, as well as above, on contrary ſides of the zenith; in that caſe they may be obſerved upon the meridian twice in the 24 hours.

CASE V.

Q. When the object is obſerved to be on the meridian below the pole, how is the latitude then found?

A. Add the complement of the declination to the true meridian altitude, their ſum will be the latitude of the ſame name as the declination.

EXAMPLE.

At ſea I obſerved the ſun's lower limb on the meridian below the pole to be 7°.50′, the declination being 22°.30′ north, and the obſerver's eye 24 feet above the ſurface: What was the latitude?

4′.40″	dip	7°.50′	
6 .37	refraction	−11	dip and refraction
11 .17	dip. and refract.	7 .39	
		+16	ſun's ſemi-diam.
90°.00′		7 .55	true altitude
22 .30	declination	67 .30	comp. declination
67 .30	comp. dec.	75 .25	latitude.

Anſ. The latitude 75°.25′ north; it being north declination.

CASE

CASE VI.

Q. How do you find the latitude, by taking two altitudes, either in the forenoon or afternoon, having the intermediate time by a common watch?

A. 1. To the arithmetical complement of the log. of the co. ſine of the latitude by account, add the arithmetical comp. of the log. of the co. ſine of the ſun's declination, and call that ſum log. ratio.

2. Subtract the hours and minutes when each altitude was taken from each other, and half the remainder, call it the half difference of elapſed time, with which enter the tables, and from the column of half elapſed time, take the logarithm anſwering thereto, and ſet it down under the logarithm ratio.

3. From the natural ſine of the greater altitude, take the natural ſine of the leaſt altitude, and find the logarithm of their diff. which ſet down under the logarithm ratio.

4. Add theſe three logarithms together, and with their ſum enter the table of middle time, where having found the logarithm neareſt thereto, take out the time correſponding to it, and put it down under the half elapſed time; ſubtract the leſs from the greater, their difference will be the time from noon when the greateſt altitude was taken.

5. With this time enter the tables, and from the column of riſing, take out the logarithm correſponding thereto, and from it ſubtract the logarithm ratio, the remainder will be a common logarithm, which being found in any table of logarithms, and added to the natural ſine

fine of the greateſt altitude, will give the natural ſine of the meridian altitude of the ſun at noon.

6. Having the meridian altitude, the latitude of the place is found by the uſual method; that is, by one of the preceding Caſes, according to which it may fall under.

N. B. Should the latitude found as above, differ greatly from the latitude by account, it will be neceſſary to repeat the operation, uſing the latitude laſt found inſtead of the latitude by account.

OBSERVATIONS on this METHOD OF FINDING THE LATITUDE.

1. It holds good any time between the hours nine A.M. and three P.M.

2. Altitudes taken ſo near together as 45 minutes, are liable to a ſmall error, particularly between nine and ten o'clock; but between ten and eleven it will hold good, provided you take full 45 minutes between them.

3. Altitudes taken one in A.M. the other in P.M. muſt not exceed five hours between them.

4. The ſpace of time between the two obſervations ſhould be longer than the ſecond altitude from noon.

5. Altitudes taken A.M. and P.M. if ten minutes elapſe between the obſervations, it is ſufficient, provided always in this caſe, that the ſpace, or portion of the diurnal arc comprehended between the higheſt altitude and the meridian altitude, be not greater than that portion (or nearly ſo

so) which answers to the half elapsed time between taking the two observations.

6. In sailing to the eastward, you must add to the elapsed time at the rate of one minute of time for every 15 miles of longitude, made between the two observations; and subtract, sailing to the westward.

EXAMPLE.

At sea, latitude by account 48°.50′ at 10h.6m. the sun's altitude per lower limb was 55°.01′, and at 11h.35m. it was 62°.55′: What was the true latitude?—the sun's declination being 22°.12′ north, and the observer's eye 20 feet above the surface.

4′.16″ dip	55°.01′	obs. alt.
0 .40 refraction	−5	dip and ref.
4 .56	54 .56	
	+16	sun's semi-diam.
	55 .12	true alt.

4°.16′ dip	62°.55′	obs. alt.
0 .29 refraction	−5	dip and ref.
4 .45	62 .50	
	+16	sun's semi-diam.
	63 .06	true alt.

h. m. N. ſine °
11.35 tr.al.63.06=89180 lat. 48.50 ar.co.of co.ſ.0.18161
10.06 tr.al.55.12=82115 ſun'sdec.22.12 ditto 0.03345

Log. ratio 0.21506
½)1.29 .7065 common log. 3.84911

0.44.30 logarithm of ½ diff. of elapſed time 0.71455

1.09.30 middle time 4.77872

0.25,00 lagarithm riſing 2.77505
log. ratio 0.21506

Common logarithm 363=2.55999
NS. of greater alt. 89180
90°.00'
89543=63 .34 meridian altitude
26 .26 zenith diſtance ſouth
22 .12 declination north
48 .38 north

Anſ. 48°.38' true latitude north.

EXERCISING EXAMPLES.

Being at ſea the 20th of May, 1783, in latitude by account 38°.40' north, at 11h. 30' 15" per watch, the ſun's obſerved altitude per lower limb was 69° 48' 45", and at 12h. 21' 45" it was 70° 58'; the height of the obſerver's eye being 21 feet above the ſurface: What was the ſhip's true latitude?

Anſ. 38°.32' north.

At ſea, latitude by account 54°, at 9h. 10' in the fore noon, the ſun's true altitude was 18°.30', and at 12h.10' his

his true altitude was 44°: What was the true latitude; the ſun's declination being 20° north?

Anſ. 54°.03′ north.

A TRUE METHOD of finding the APPARENT TIME at SEA, and thereby to regulate the going of a WATCH.

Q. How is this performed?

A. By adding together the co. latitude, zenith distance, and polar diſtance; from half that ſum ſubtract the zenith diſtance, and note the remainder; then add together the arithmetical complements of the ſines of the co. latitude, and polar diſtance, and the logarithm ſines of half the ſum, and remainder; the half ſum of theſe four logarithms is the co. ſine of half the horary angle or diſtance of the ſun from noon, which you muſt turn into time, by allowing 15 degrees to one hour, &c.

EXAMPLE.

At ſea, latitude 48°.38′ north, at 15 minutes paſt 11 per watch, the ſun's true altitude was 63°.06′ declination, 22°.12′ north: Was the watch too faſt or too ſlow?

	90°.00′	90°.00′	90°.00′
	48 .38	63 .06	22 .12
Co. lat.	41 .22	26 .54 zen. dist.	67 .48 polar dist.
Zenith dist.	26 .54		
Polar dist.	67 .48		
	½)136 .04 sum		
Half sum	68. 02		
Zenith dist.	26. 54		
Remainder	41 .08		

add { s. co. la. 41°.22′ ar. co. =0.17988
SP. dist. 67 .48 ar. co. =0.03345
s. half sum 68 .02 =9.96727
s. remaind. 46 .08 =9.81810 }

½)19.99870

2°.8′ Co. sine .... =9.99935
2

5)6.16

3)1.15.12″

0.25.04
12.00.00

11.34.56 app. time
11.15.00 time per watch

Ans. 0.19.56 watch too slow.

EXERCISING EXAMPLES.

As sea, per watch 2h.30′ PM. latitude 16°.24′ north, I observed the sun's true altitude to be 47°.24′ : Was the watch too fast or too slow?---the declination was 5°.42′ south.

Ans, The watch was too fast 2′.40″.

At

At sea the 3d of June, 1782, at 58′ after 7 A.M. per watch, the sun's lower limb was observed to be 36°.30′ when the observer's eye was 21 feet above the surface, the latitude in 34°.55′ north: Was the watch too fast or too slow?

Ans. Watch too slow 2′.

Of finding the Longitude at Sea by Sun and Moon, or Moon and a known fixt Star.

Q. What must be given to find the longitude at sea by this method?

A. The apparent altitudes of the centres of the sun and moon (or moon and a known fixt star) together with the apparent distance of their centres; also the time of observation by a well regulated watch.

Q. How is the longitude then found?

A. 1st. From the proportional logarithm of the moon's horizontal parallax (its index being increased by 10) subtract the log. sine of the moon's zenith distance, and the remainder is the proportional log. of her parallax in altitude; from which subtract the moon's refraction, the difference will be the correction of the moon's altitude (or which is the same) the correction of her zenith distance.

2d. Add together the logarithm tangents of half the sum, and half the difference of the apparent zenith distance of the sun and moon, and the log. co. tangent of half the observed

observed distance, their sum (rejecting twice the radius) is the log. tangent of an arc which call A.

3d. When the sun's zenith distance is less than the moon's, the difference between the arc A, and half the observed distance, is to be taken; otherwise their sum, and refraction corresponding to the complement of their sum, or difference, (or supplement when greater than 90 degrees) will be the first correction of the observed distance.

4th. If the difference of the arc A, and half the observed distance was used in the preceding rules, let their sum be now taken, otherwise their difference; and to the log. co. tangent of that sum or difference, add the log. tangent of the moon's zenith distance, and the proportional log. of the correction of her zenith distance, that sum (rejecting twice the radius) will be the proportional log. of the second correction of the observed distance.

5th. If the arc A be less than half the observed distance, the first correction is always to be added to, and the second subtracted from the observed distance, but when the arc A is greater than half the observed distance, both the first and second corrections must be added, if the sun's zenith distance be greater than the moon's, otherwise both must be subtracted; and these two corrections being applied, give the correct distance of the sun and moon.

6th. Add together the proportional logs. of the sum and difference of the correction of the moon's zenith distance, and the second correction of the observed distance, the log. tangent of the second corrected distance, and

and the conſtant log. 9.8039, the ſum of theſe four logs. (rejecting twice the radius, will be the proportional log. of the third correction of the obſerved diſtance (expreſſed in ſeconds and thirds) to be added to the ſecond corrected diſtance, when the ſecond corrected diſtance is leſs than a quadrant, or 90 degrees; otherwiſe ſubtract, and the ſum or difference will be the true diſtance required; which being obtained, the longitude will be found as follows:

7th. In the ephemeris, amongſt the diſtances of the objects on the day of obſervation, look for this true diſtance; and if it be there, the time of obſervation at Greenwich, is at the top column, but ſhould this diſtance fall between two diſtances (which generally is the caſe) then ſay, as the difference between the two neareſt diſtances in the ephemeris is to three hours, ſo is the difference between the firſt of theſe diſtances and the true diſtance to the difference of time, which being added to the hours ſtanding over the firſt diſtance in the ephemeris, gives the true time of the obſervation at Greenwich.

8th. The difference between the time at Greenwich and that at the ſhip, being turned into longitude, gives the ſhip's true longitude from Greenwich, either eaſt or weſt; if it be eaſt, the time at the ſhip will be greater than at Greenwich; if weſt, leſs.

N. B. If the diſtance of the moon from a known fixt ſtar is obſerved, the preceding rules will require no other alteration than reading ſtar inſtead of ſun.

At

QUESTION I.

At sea the 3d of April, 1782, in longitude per account 81°.20′ west, at 8h.9′.15″ A.M. per watch well regulated, I observed the distance of the sun and moon's nearest limbs to be 108°.0′.14″ when the moon's altitude was 14°.40′ per upper limb, and the sun's altitude 30°.25′ per lower limb, the height of the eye being 28 feet above the surface: What was the true longitude?

Sun and Moon's obs. dist.	Moon's obs. alt.	Sun's obs. alt.
108°. 0′.14″	14°.40′.00″	30°.25′.00″
+ 16 .01 sun's semi-diam.	—21 .18 semi-dia. dip of hor. & aug.	+16 .01 sun's semi-dia.
+ 16 .11 moon's semi-diam.	14 .18 .42 moon's app. alt.	30 .41 .01
+4 augm.		—5 .03 dip. of horizon
108 .32 .30 sun and moon's app. dist.		30 .35 .58 sun's app. alt.

	app. time.	☉ obs. dist. from ☽	☽ app. alt.	☉ app. alt.	Hor. Par.
3d April, 1782.	8h.9′.15″	108°.32′.30″	14°.18′.42″	30°.35′.58	59′.20″
			90 .00 .00	90 .00 .00	
		Moon's Z. dist.	75 .41 .18	59 .24 .02 sun's Z. dist.	

Hor. Par. ....0° 59′.20″ p. log. = 10.4820
Moon's Z. dist. ....75 .41 .18 log. sine = 9.9863
Par. in alt. ....57 .29 p. log. = 0.4957
Refraction ....—3 .41
Corr. moon's Z. dist. = 53 .48

Sun's Z. dist. 59 .34
Sum ..... 135 .05 } ½ { = 67°.32′ tang. = 10.38349
Diff. ..... 16 .17 } ½ { = 8 .08 tang. = 9.15508
Obs. dist. .... 108 .32 } ½ { = 54 .16 co. tang. = 9.85700

Arc A 13 .58 tang. 9.39557
Diff. 40 .18 comp. 49°.42′ Refrac. 48″ Cor. 1st.
Sum 68 .14 co. tang. = 9.60130
Moon's Z. dist. 75 .41 tang. = 10.59311
Corr. ☽ Z. dist 53.48 p. log. = 0.52450
2d cor. 34.23 p. log. = 0.71891
Sum 1 .28.11 p. log. = 0.3099
Diff. 19.25 p. log. = 0.9671

Moon's obs. dist.
108°.32′.30″
+48 1st cor.
108 .33 .18 1st cor. dist.
+34 .23 2d cor.
L
107 .58 .55 2d corr. dist.
+5 3d cor.
–107 .58 .50 3 cor. dist.

2d corr. ☽ }
Z. dist. } sup. = 72 .02 tang. = 10.4891
107°.58′ }
Constant log. 9.8045
3d. cor. 4.″50‴ p. log. = 1.5706

Two nearest } 108°.49′.24″ 108°.49′.24″
distances } 107 .11 .04 true dist. 107 58 .50 12h.00′.00″
As the diff. 1 .38 .20 .. 3h : : 50 .34 1 .32 .34
13 .32 .34 time at Greenwich
8 .09 .15 time at ship
As 1h. . . 15° : : 5 .23 .19 . . 80°.49′.45″

Ans. The ship's true longitude is 80°.49′.45″W. as the time at ship is less than that at Greenwich.

QUESTION II.

Being at sea the 22d of May, 1782, in longitude per account 104°.30′ east, at 7h.52′ 57″ PM. by a well regulated watch, I observed the distance of the moon's farthest limb from the star Antares to the east of the meridian to be 68°.17′.10″ and at the same time two assistants observed, one the altitude of the moon's lower limb 46°.30′, the other the star Antares 34°.20′, the height of the eye was 30 feet above the surface: Required the ship's true longitude?

Moon's obs. alt.	Moon's obs. alt.	Star's obs. alt.
68°. 17′.10″	46°.30′.00″	34°.20′.00″
−16 .22 moon's semi-diam. and aug.	+16 .11 semi-diam.	−5 .14 dip of horiz.
	+11 aug.	
68 .00 .48 moon and star's app. dist.		34 .14 .46 star's app. alt.
	46 .46 .22	
	−5 .14 dip of horiz.	
	46 .41 .08 moon's app. alt.	

	app. time.	☽ obs. dist. from *	☽ app. alt.	* app. alt.	Hor. Par.
22d May, 1782.	7h.52′.57″	68°.00′.48″	46°.41′.08″	34°.14′.46″	59′.52″
			90 .00 .00	90 .00 .00	
		Moon's Z. dist.	43 .18 .52	55 .45 .14	star's Z. dist.

Hor. Par.	0° 59′.25″	p. log.	=10.4813
Moon's Z. dist.	43 .19	log. sine	= 9.8363
Par. in alt.	40 .45	p. log.	= 9.6450
Refraction	−00 .54		
Corr. moon's Z. dist.	39 .51		

Moon's Z. dist. 43°.19′
Star's Z. dist. 55 .45

Sum .... 99 .04 ⎫ ⎧ = 49°.32′ tang. = 10.06901
Diff. .... 12 .26 ⎬ ½ ⎨ = 6 .13 tang. = 9.03714
Obs. dist. .... 68 .00 ⎭ ⎩ = 34 .00 co. tang. = 10.17101

Arc. A 10 .43 tang. 9.27716

Sum 44 .43 comp. 45°17′ ref. 57″ cor. 1st.
Diff. 23 .17 co. tang. = 10.36621
Moon's Z. dist. 43 .19 tang. = 9.97447
Corr. ☽ Z. dist. 39 51″ p. log. = 0.65480
2d corr. .... 18 11 p. log. = 0.99548
Sum .... 58 .02 p. log. = 0.4916
Diff. .... 21 .40 p. log. = 0.9195
2d corr. dist. 67 43 .34 tang. = 10.3878
Constant log. 9.8045
3d corr. .... 4″.29‴ 1.6034

Moon's obs. dist.
68°.00′.48″
+57 1st corr.
68 .01 .45 1st. cor. dist.
−18 .11 2d corr.
67 .43 .34 2d corr. dist.
+4 3d corr.
67 .43 .38 3d corr. dist.

The 2 nearest ⎫ 68°.18′.29″ —— 68°.18′.29″
distances ⎭ 66 .32 .16 true dist. 67 .43 .38

As the diff. ..... 1 .46 .13 . . 3h. : : 00 .34 .51 . . 0h.59′. 4″ time at Greenwich
7 .52 .57 time at ship

As 1h. . . 15 : : 6 .53 .53 . . 103°.28′

Ans. The ship's true long. 103°.28′ E. as the time at ship is more than at Greenwich.

EXERCISING EXAMPLES.

Being at ſea the 2d of June, 1782, longitude per account 77° eaſt, at 8 h.35′.46″ AM. per watch well regulated, I obſerved the diſtance of the ſun and moon's neareſt limbs 86°.39′.40″, when the moon's altitude per lower limb was 50°.25′, and the ſun's altitude per lower limb 13°.20′, the obſerver's eye being 24 feet above the ſurface: What was the true longitude?

Anſ. The ſhip's true longitude is 77°.27′.15″ eaſt, as the time at the ſhip is more than at Greenwich.

At ſea the 20th of October, 1782, in longitude per account 76°.30′ weſt, at 9h.46′.56′ PM. by a well regulated watch, I obſerved the diſtance of the moon's neareſt limb from the ſtar Aldebaran to be 40°.34′.28″, the moon's altitude at that time being per upper limb 44°.05′ and the ſtar Aldebaran's altitude 22°.54′, the obſerver's eye being 27 feet above the ſurface: Required the ſhip's true longitude?

Anſ. The ſhip's true longitude was 77°.44′.30″ weſt. the time at the ſhip being leſs than at Greenwich.

ON RECTIFYING COURSES.

CASE I.

The COURSE Steered by the COMPASS and VARIATION given, the CORRECT or TRUE COURSE required.

N. B. You muſt ſuppoſe yourſelf placed in the centre of the compaſs, and looking from thence towards the different points thereon.

Q. How

Q. How is this case performed?

A. If the variation is east, count the variation to the right-hand of the course steered by the compass; but if west, to the left-hand; and it will give the true course required.

EXAMPLES.

If I steer SWbyW. by the compass, when the variation is one point west: What's the true course?

Variation, 1 point towards the left-hand, (it being W. variation) from SWbyW makes it SW. the true course.

Ans. SW.

Course by the compass SWbyW. variation 1 point east: What's the true course?

Variation 1 point towards right-hand, (it being east variation) from SWbyW. makes it WSW. the correct course.

Ans. WSW.

Course by the compass EbyS½E. variation 1½ point west: What's the true course?

Ans. EbyN.

Course by the compass NW¼W. variation 1¾ west: What's the correct course?

Ans. WNW.

Course by the compass NW¾W, variation 1¾ east: What's the true course?

Ans. NNW½W.

Course

Courſe by compaſs due N. variation 27°.30′ weſt: What's the correct courſe?

Anſ. NNW½W. nearly.

Courſe by the compaſs E. 8°.27′ N. variation 5°.22′ eaſt: What's the true courſe?

Anſ. E. 3°.5′ N.

Courſe by the compaſs SSE¼E. variation 17°.25′ weſt: What's the correct courſe?

Anſ. SEbyS¼E. 32′ eaſt.

CASE II.

The COURSE Steered by the COMPASS, LEE-WAY and VARIATION given, the CORRECT COURSE required.

Q. How is it performed in this caſe?

A. When the lee-way and variation are both one way, that is both to the right-hand or left, their ſum corrected by caſe firſt, is the true courſe required. But when contrary ways, their difference is to be corrected the ſame way the greater was to be allowed for.

EXAMPLES.

Courſe by compaſs ENE. wind at north, lee-way 1¾ points, variation 1¼ eaſt: What's the true courſe?

$$\left.\begin{array}{l}\text{Lee-way } 1\tfrac{3}{4} \text{ pts. right-hand}\\ \text{Variation } 1\tfrac{1}{4} \text{ do.}\end{array}\right\} \textit{Anſ.}\ \text{EbyS.}$$

3 Points towards the right-hand from ENE, makes it EbyS. the correct courſe.

Courſe

Course by compass NW. wind at NNE. lee-way 1½ point, variation 1½ west: What's the true course?

Lee-way 1½ points left hand
Variation 1½ do.
—
3 Points towards the left hand from NW.
— makes it WbyN. the true course.

Ans. WbyN.

Course by compass SSW. wind SE. lee-way 1¼ points, variation ¾ west: What's the true course?

Lee-way 1¼ points right hand
Variation ¾ left do.
—
½ Point towards the right hand (it being the greater) from SSW. makes it SSW½W. the true course.

Ans. SSW½W.

Course by compass SE. wind SSW. lee-way ½ point, variation 1¾ east: What's the true course?

Variation 1¾ points right hand
Lee-way ½ left hand
—
Variation 1¼ right hand
—

Ans. SEbyS¼S.

Course by compass NE. wind ESE. lee-way 5½, variation 2 points west: What's the true course?

Lee-way 5½ points left hand
Variation 2 do.
—
Var. & lee-way 7½ left hand.

Ans. NWbyN½W.

Course by compass SE½E. wind NEbyE½E. lee-way 4 points, variation 1½ west: What's the true course?

Lee-way 4 points right hand
Variation 1½ left-hand
—
Lee-way 2½ right hand.
—

Ans. SSE.

CASE

CASE III.

The TRUE COURSE from PLACE to PLACE, and the VARIATION given, the COURSE to STEER by the COMPASS required.

Q. What is the rule for this case?

A. If the variation is eaſt, count the variation to the left-hand of the true courſe, and you have the courſe by the compaſs to ſteer; but if weſt, variation to the right-hand of the true courſe.

EXAMPLE.

True courſe from place to place, SW. variation 1 point weſt: What's the true courſe by the compaſs?

Variation 1 point towards the right hand, from SW. makes SWbyW. the courſe to ſteer by compaſs. } *A.* SWbyW.

True courſe from place to place WSW. variation 1 point eaſt: What's the courſe by the compaſs?

Variation 1 point towards the left hand, from WSW. makes SWbyW. the courſe to ſteer by compaſs } *A.* SWbyW.

True courſe from place to place, NE½E. variation ½ point weſt: What's the courſe by the compaſs?

Anſ. NEbyE.

True courſe from place to place, NE½N. variation ½ point weſt: What's the courſe by the compaſs?

Anſ. NE.

True

True courſe from place to place, EbyN. variation $1\frac{1}{2}$ points weſt: What's the courſe by the compaſs?

Anſ. ENE$\frac{1}{2}$N.

True courſe from place to place NNW$\frac{1}{2}$W. variation $1\frac{1}{2}$ points weſt: What's the courſe by the compaſs?

Anſ. NW$\frac{1}{4}$W.

True courſe from place to place, WNW. variation $1\frac{3}{4}$ weſt: What's the courſe by the compaſs?

Anſ. NW$\frac{1}{4}$W.

True courſe from place to place, NNE$\frac{1}{2}$E. $37\frac{1}{2}$N. variation $27^{\circ}.30'$ eaſt: What's the courſe by the compaſs?

Anſ. N.

True courſe from place to place, E. $3^{\circ}.5'$ N. variation $5^{\circ}.21'$ eaſt: What's the courſe by the compaſs?

Anſ. E. $8^{\circ}.26'$ N.

True courſe from place to place, SEbyS$\frac{3}{4}$E. variation $17^{\circ}.25'$ weſt: What's the courſe by the compaſs?

Anſ. SSE$\frac{1}{4}$E. nearly.

The General Average for Allowance of Lee-way.

1 Cloſe hauled, all ſails ſet, and moderate gale; no lee-way.

2 Blow freſh, ſmall ſails taken in; 1 point lee-way.

3 Top-ſails cloſe reeſt; 2 points.

4 One top-ſail handed; $2\frac{1}{2}$ points.

5 Both top-ſails taken in; $3\frac{1}{2}$ points.

6 Fore courſes handed; 4 points.

7 Trying

7 Trying under a mainſail; 5 points.
8 Main and fore courſes taken in; 6 points.
9 Trying a hull with all ſails handed; 7 points.
10 When lying too, under a mainſail, mizen, &c. her coming up and falling off ſhould be well obſerved; then the courſe to be corrected, muſt be between the 2 points ſo coming up and falling off.

COROLLARY.

Hence, and by the variation of the compaſs, a ſhip's true courſe may be found; yet as many accidents attend a ſhip ſailing, ſuch as unknown currents, want of care at the helm to keep her ſteady, the different rates of velocity between the time of heaving the log. ſudden ſqualls of wind, &c. &c. the latitude by account will frequently differ from that attained by obſervation; and when this happens, great care muſt be taken to correct the ſhip's reckoning after the following manner, for by it the artiſt may always correct, whenever the latitude by account differs from that obtained by obſervation, whence the true place of a ſhip may at any time be found; and every artiſt ſhould be very careful, and ſpare no pains in performing it in the moſt accurate manner poſſible, ſince not only credit, but alſo the lives and ſafeties of all on board depend thereon.

*** In taking your departure from any land, the back bearing (that is the point oppoſite to the bearing) and diſtance you judge yourſelf from it, muſt be conſidered as a

a courſe and diſtance, and corrected as ſuch, allowing the variation upon it; likewiſe the ſetting of current ſwells, &c. &c. and the diſtance you ſuppoſe yourſelf driven by them, muſt be conſidered as a courſe and corrected as above.

N. B. The following rules for correcting the dead reckoning by an obſervation, I ſhall work by inſpection from the difference of latitude and departure table; as by it, will be ſufficient to ſhew the learner the uſe of this table in working any queſtion in plane, traverſe, middle latitude, or Mercator's ſailings; which method (for the ſake of expedition) is chiefly uſed at ſea, in working a day's work, or keeping a ſhip's reckoning; however I recommend to every artiſt to work it mathematically, and by a conſtant practice of it, he will find no great deal of difference reſpecting the expedition; whereby by working it mathematically, he may be aſſured of exactneſs and truth, but by inſpection it is impoſſible to do it with ſo much certainty.

RULES for CORRECTING the DEAD RECKONING by an OBSERVATION, by INSPECTION.

C A S E I.

When the courſe by dead reckoning (or by account) is near the meridian, that is leſs than 3 points or 33°, the error is then ſuppoſed to ariſe from the diſtance, becauſe a ſmall error in the courſe will cauſe but very little difference in the latitude.

RULE.

RULE.

With the courſe found by dead reckoning, and the meridian difference of latitude by obſervation, find the difference of longitude.

EXAMPLE.

Yeſterday at noon, by obſervation, we were in latitude 49°.41′ north, and this noon in 48°.21′ north, when our dead reckoning gave 91 miles of ſouthing, and 42 miles of weſting: Required the true difference of longitude.

Look into the table of difference of latitude and departure, for 91 lat. and 42 dep. the neareſt to this (at the top) is 25 degrees, which is equal to the courſe, then with the meridian difference of latitude between the obſervations, which is 122 lat. and the courſe 25 degrees, you have for dep. (equalling your difference of longitude) 57.1′ your true difference of longitude.

CASE II.

When the courſe by dead reckoning is more than 3 points, or 33 degrees, and leſs than 5 points or 56°, the error may then ariſe partly in the diſtance, and partly in the courſe, to correct for this, obſerve as follows.

RULE.

Find the courſe and diſtance by account, then with the difference of latitude by obſervation, and diſtance by account, find a new departure, which add to the departure found

found by dead reckoning, the half sum thereof will give the true departure; again, with the true departure and difference of latitude by observation, find the true course; then with the true course and meridian difference of latitude between the observations, find the difference of longitude, which will be the true difference of longitude as required.

EXAMPLE.

Yesterday at noon, by observation we were in the latitude 48°.21′ north, and this noon in latitude 47°.10′ north, having by account made 60 miles of southing, and 54 of westing: Required the true difference of longitude?

Look into the table of difference of latitude and departure, for 60 latitude and 54 dep. over which you will find 42 degrees equal to the course, and in the distance column is 81 equalling the distance; again with the distance 81 and difference of latitude (between the two observations) equalling 71, against this in the dep. column is 39.3, which being added to 54 (the dep. by dead reckoning) is equal to 93.3 the half of which is 46.6 the true departure; then with the true departure 46.6, and the difference of latitude by observation 71, the true course is 33 degrees, and dist. 85; with this course 33 degrees, and the merid. diff. of latitude between the two observations, which is 106, I find the departure is 68.6 equal to the true difference of longitude as required.

CASE III.

When the course by dead reckoning is near the parallel of east and west, that is more than 5 points or 56 degrees, the error must then in general result from the course; because an error in the distance must be very large to make any considerable difference in the latitude.

RULE.

Find the distance by dead reckoning, then with the distance and difference of latitude by observation, find a course, with this course and the meridian difference of latitude between the two observations, find the true difference of longitude.

EXAMPLE.

Yesterday at noon by observation we were in latitude 47°.10′ north, to-day at noon by observation we find ourselves in latitude 45°.58′, when by account we have made but 58 miles of southing, and 120 of westing: Required the true diff. of longitude?

With the diff. of latitude 58, and dep. 120, I find in the table the distance to be 133 nearly, then with 133 the dist. and 72 lat. (by observation) the true course is 57 degrees; again with this course 57°, and the merid. difference of latitude between the two observations, which is 104 lat. against this I find in the dep. column 160.2, which is the true diff. of longitude required,

To

To CORRECT for SEVERAL DAYS.

RULE.

Take the whole of the northings, ſouthings, eaſtings, and weſtings ſince your laſt obſervation, as alſo for the day you correct on, and bring them into a traverſe table, which will give you the whole difference of latitude and departure ſince your laſt obſervation; with this difference of latitude and departure, find a courſe, and obſerve which of the preceding caſes it falls under, then correct by that caſe as directed.

EXERCISING EXAMPLES of DAYS WORKS.

Yesterday noon we were in the lat. 48°.20′ N. and long. 8°.30′ W. and we have sailed till this day noon as per log. Required the course and dist. made good, with the lat. and long. the ship is in, also the bearings and dist. of Ushant?

N. B. H. stands for Hour, K for Knot or Mile, and F. for Fathom—7 Fathoms make one Knot.

The LOG BOARD.

H.	K.	F.	Courses.	Winds.	Lee-way	Remarks, &c.
1	3	4	NW.	NNE.	1½	
2	3	4				
3	3	4				
4	3	4				
5	4	0				
6	4	—				
7	4	—				
8	4	6				
9	4	2			1	
10	4	2				
11	4	2				
12	5	—				
1	5	—				
2	5	—				
3	4	6	NWbyW.	NbyE.	1	
4	4	4				
5	4	—				
6	4	—				
7	4	2				
8	4	2				
9	4	2				
10	4	4				
11	4	4				Variation 1½ Point W.
12	4	4				

Courses corrected.	Points.	Dist.	Northing.	Southing.	Easting.	Westing.
W by N.	7	31	6.0	———	———	30.4
WNW$\frac{1}{2}$W.	6$\frac{1}{2}$	28	8.1	———	———	26.8
W by N$\frac{1}{2}$W.	7$\frac{1}{2}$	44	4.3	———	———	43.8
			18.4			101.0

As diff. lat. = 18′.4 =
.. radius = 90° =
:: depart. = 101′ =
.. t. course = 79°.41′ =

As s. cou. = 79°.41′ =
.. depart. = 101′ =
:: radius = 90° =
.. dist. = 102′.7 =

Merid. Parts.

Yesterday's la. 48°.20′ N = 3332
To-day's d. la. 00 .18 N =
To-day's la. in 48 .38 N = 3349
MD. lat. 27

As rad. = 90° =
.. MD. la. = 27′ =
:: t. cou. = 79°.41′ =
:: di. lon. = 148.3 =
2.28 W.

Yesterday's long. 8°.30′ West
This day's diff. long. 2 .28 West
This day's long. in 10 .58 West.

To find the Bearing and Distance of Ushant, it is thus:

Merid. Parts.

Ship's lat. in 48°.38′ N = 3349
Ushant's lat. 48 .30 N = 3337
PD. lat. 00 .08 MD. la. 12

Ship's long. in 10°.58′ West
Ushant's long. 5 .05 West
5 53
60
Diff. lon. miles 353

As MD. la. = 12′ =
.. radius = 90° =
:: di. lon. = 353′ =
.. t. bear. = 88°.03′ =

As radius = 90° =
.. PD. lat. = 8′ =
:: sec. bear. = 88°.03′ =
.. dist. .... = 235′.1 =

Ans. Course N. 79°.41′ W. distance 102.7 miles, latitude in 48°.38′ N. longitude 10°.58′ W. Ushant S. 88°.03′ E. distance 235.1 miles.

We were yesterday noon in lat. 20°.30′ S. and long. 5°.20′ E. and have sailed till this day noon, as per log. in a current setting S. 1½ mile per hour: Required the course and distance made good, also the ship's place, with the bearing and distance of Cape Good Hope.

H.	K.	F.	Courses.	Winds.	Lee-way.	Remarks, &c.
1	4	4	SbyE.	EbyS.	1	
2	4	4				
3	4	2				
4	4	—				
5	4	—				
6	4	4				
7	4	6				
8	5	—	SSE.	East.	¾	
9	5	—				
10	5	2				
11	5	4				
12	5	4				
1	5	3				
2	5	2				
3	5	2				
4	5	6				
5	6	—			½	
6	6	—				
7	6	2				
8	6	1				
9	6	3				
10	6	4				
11	6	4				Variation 1 Point West.
12	6	6				

Courses corrected.	Points.	Dist.	Northing.	Southing.	Easting.	Westing.
SbyE.	1	31	——	30.4	6.0	——
SSE¼E.	2¼	48	——	43.4	20.5	——
SSE½E.	2½	51	——	45.0	24.0	——
SbyE.	1	36	——	35.3	7.0	——
				154.1	57.5	

As diff. lat. =154′.1 =
.. radius =90°. =
:: depart. =57′.5 =
.. t. cou. =20°28′ =

As s. cou. =20°.28′ =
.. depart. =57′.5 =
:: radius =90°. =
.. dist. =164′.4 =

M. parts.

Yesterday's lat. 20°.20′ S. 1257
This day's d. lat. 2 .34 S.
Ship's lat. in 23 .04 S. 1423
m. d. lat. 166

As radius =90°. =
.. m. d. lat. =16′6 =
:: t. course =20°.28′ =
.. diff. long. =61.96 =

Yesterday's longitude 5°.20′ east.
This day's diff. long. 1 .02 east.
Ship's long. in 6 .22 east.

To find the Bearing and Distance of Cape Good Hope, it is thus:

			M. parts.		
Ship's lat. in	23°.04′ S.	1423	Ship's long. in	6°22′ east.
The cape's lat.	34 .29 S.	2207	Cape's lon.	18 23 east.
Diff. lat.	11 .25 S.		Diff. long.	12 01 east.
	60	m. d. lat. 784		60
P. d. lat.	685			721

As m. d. lat. =784′ =
.. radius =90° =
:: diff. long. =721′ =
.. t. bear. =42°36′ =

As radius =90°. =
:: p. d. lat. =685′ =
.. sec. bear. =42°.36′ =
.. distance =930′6 =

Ans. Course S. 20°.28′ E. distance 164.4 miles, latitude in 23°.04′ S. longitude 6°.22′ E. Cape Good Hope, S. 42°36′ E. distance 930.6.

Being

Being yeſterday at noon in lat. 46°.30N. and long. 10°.20′ weſt, at 8 P.M. the ſun was obſerved to ſet weſt 53.10′ N. declination 22°.30′ N. and we have ſailed till this day noon, as per log, the tide having all the time ſet SSE. 2′¼ per hour: Required the courſe and diſtance made good, alſo the ſhip's place, with the bearing and diſtance of Cape Finiſterre?

H.	K.	F.	Courſes.	Winds.	Lee-way.	Remarks, &c.
1	6	—	SWbyW¼W.	NW.	0	
2	6	—				
3	6	—				
4	6	—				
5	6	2				
6	6	2				
7	6	2				
8	6	2				The ſun ſet W.
9	5	4	SWbyS.	WbyN.	½	53°10′ to the
10	5	2				Northward.
11	5	2				
12	5	2				
1	5	2				
2	5	2				
3	5	2				
4	4	4	SSW½W.	W½N.	1	
5	4	4				
6	4	3				
7	4	3				
8	4	3				
9	4	2				Variation per am-
10	4	2				plitude 1¾ points
11	4	2				W.
12	4	2				

Courſes corrected.	Points.	Diſt.	Northing.	Southing.	Eaſting.	Weſting.
SW.	4	49	——	34.6	——	34.6
S$\frac{3}{4}$W.	$\frac{3}{4}$	37	——	36.6	——	5.4
S$\frac{1}{4}$E.	$\frac{1}{4}$	39	——	39.0	1.9	——
SEbyS$\frac{3}{4}$E.	3$\frac{3}{4}$	66	——	48.9	44.3	——
				159.1	46.2	40.0
					40.0	
					6.2	

Lat. at noon	46°.30′ N.	As ſ. co. lat.	=44°.21′ =
diff. lat. at 8 PM. allowing for cur.	0 .51 S.	.. radius	=90 . =
		:: ſ.☉ dec.	=22 .30 =
lat. in at 8 PM.	45 .39 N.	.. ſ. tr. amp.	=33 .12 =
	90	mag. amp.	=53 .10 =
co. lat. at 8 PM.	44 .21	variation	..........19 .58 W.

As diff. lat.	=159′ 2=	As ſ. couſ.	2°.14′ =
.. radius	=90° =	.. depart. =	6 .2 =
:: depart.	= 6.2′ =	:: radius =	90 =
.. t. courſe	=2°.14′ =	.. diſt.	=159.1 =

	M. parts.		
Yeſterd. lat. 46°.30′ N.	=3150	As rad.	=90°. =
diff. lat. 2 .39 S.	=	.. m. d. lat.	=226′ =
ſhip's lat. in 43 .51 N.	=2933	:: t. courſe	=2°.14′ =
m. d. lat.	226	.. diff.long.	=8.814 =

Yeſterday's long. 10°.20′ W.
Difference long. 0 .09 E.
Ship's long. in 10 .11 W.

To find the Bearing and Distance of Cape Finiſterre.

	M. parts.		
Ship's lat. in 43°.51′ N	=2933	Ship's long. in	=10°.11 W.
Cape Fin. lat. 42 .52 N	=2852	Cape's long.	= 9 .17 W.
p. d. lat. 00 .59	m.d. lat. 81		0 .54

As m.d. lat.	=81′ =	As radius	=90° =
.. radius	=90° =	.. p. d. lat.	=59′ =
:: diff.long.	=54′ =	:: ſec. bear.	=33 .41 =
.. t. bear.	=33°.41=	.. diſtance	=709′ =

Anſ. Courſe S. 2°.14′ E. diſt. 159 miles, lat. in 43.51 N. lon. 10°.11′ W. Cape Finiſterre S. 33°.41′ E. diſt. 70.9 miles. We

We were yesterday noon, in latitude 42°.30′ N. and longitude 11°.30′ west, and this morning at 6 A.M. we observed the sun's altitude to be 14°.30′, when his declination was 15°.20′ north, he then bearing E. 9°.20′ S. and we have sailed till this day noon, as per log, in a swell from the SW. for which we allow 12′ for the 24 hours: Required the course and distance made good, also the ship's place, with the bearing and distance of Oporto.

H.	K.	F.	Courses.	Winds.	Leeway.	Remarks, &c.
1	5	5	EbyN.	SSE.	½	
2	5	4				
3	5	6				
4	5	6				
5	6	—				
6	6	—				
7	6	4				
8	6	4	East.	——	½	
9	6	3				
10	6	4				
11	6	4				
12	7	—			0	
1	7	—				
2	7	1				
3	7	3				
4	7	2				
5	6	4				
6	6	—				The sun's alt. 14°.30′.
7	5	4	E½N.	SSE½E	½	dec. 15°.20′ N.
8	5	2				
9	5	2				
10	5	—				Variation 1½ points W.
11	5	—				per azimuth.
12	5	—				

Courses corrected.	Points.	Dist.	Northing.	Southing.	Easting.	Westing.
NEbyE.	5	41	22.8		34.1	
ENE.	6	26	10.		24.0	
ENE½E.	6½	48	13.9		45.9	
NEbyE½E.	5½	31	14.6		27.3	
NNE½E.	2½	12	10.6		5.7	
			71.9		137.0	

Lat. at noon 42°.30′ N.
Diff. lat. at 6 AM. allowing for the swell } 0 .54 N.
Lat. in at 6 AM. 43 .24 N.
90

Co. latitude .... 46 .36
Co. altitude .... 75 .30
Sun's distance .... 74 .40
½)196 .46 sum
98 .23 half sum
74 .40 sun's dist.
23 .43 remainder

	90°	90°
	14 .30′ alt.	15 .20′ dec.
Co. alt.	75 .30	74 .40 ☉ dist. from the pole.

S. co. lat. =46°36′=9.86128 its arith. co.=0.13872
S. co. alt. =75 30 =9.98594 ditto ....=0.01406
S. ½ sum =98 23 = ...=9.99533
S. rem. =23 43 = ...=9.60446
½)19.75257
co. sine 41°.14′=9.87628
2

True az. N. 82 .28 E.
90

True az. E. 7 .32 N.
Mag. az. E. 9 .20 S.
Variation 16 .52 W.

As diff. lat. =719' =	As s. course =62°18' =
. . radius =90° =	. . depart. =137' =
: : depart. =137' =	: : radius =90° =
. . t. cou. =62°.18' =	. . distance =154'.7 =

Merid. Parts.

Yesterd. lat. 42°.30' N=2822	As radius =90° =
Diff. lat. 1.12	. . MD. lat. =99 =
	: : t. course =62.18 =
Ship's lat. in 43.42 N=2921	
	. . diff. long. =188.5 =
MD. lat. 99	
	3.08 =

Yesterday's long. 11°.30' W.
Difference long. 3.08 E.

Ship's long. in......... 8.22 W.

To find the BEARING and DISTANCE of Oporto, it is thus:

Merid. Parts.

Ship's lat. in 43°.42' N=2921	Ship's long. in = 8°.22' W.
Oporto's lat. 41.10 N=2715	Oporto's long. = 8.27 W.
2.32MD. la. 206	D. long. 0.5 W.
60	
PD. lat. 152	

As M. diff. lat. =206 =	As radius =90° =
. . radius =90° =	. . PD. lat. =152 =
: : diff. long. =5' =	: : sec. bear. =1°24' =
. . t. bearing =1°.24 =	. . distance =152.1 =

Ans. Course N. 62°18' E. dist. 415.7 miles, latitude in 43°42' N. longitude 8°22' W. Oporto S. 1°.24' W. distance 152.1.

A LOG

7

A 533. f 23

L O G

OF A

HIP's VOYAGE,

FROM THE

DOWNS TO GIBRALTAR,

In his MAJESTY's Ship

The CUMBERLAND:

KEPT BY

JOHN DILIGENT, MASTER.

N

The LOG BOARD.

H.	K.	F.	Courſes.	Winds.	Lee way.	Remarks, &c. Tueſday 13th Auguſt, 1782.
1						Fine and moderate
2						weather.
3						Hove ſhort.
4						
5			WbyN.	North.		Weighed and ſailed.
6						
7						
8						
9						Unbent the cables and
10						ſtowed the anchor.
11						
12			Weſt.			Do. weather.
1						
2						
3						
4						
5						
6						
7			WbyN.	NbyE.		Beachy-head north a-
8						bout 8 miles.
9						Freſh gales and ſqually.
10						
11						Bembridge Point NW
12						by W. 4 leagues.

The LOG BOARD.

H.	K	F.	Courses.	Winds.	Lee-way.	Remarks, &c. Wed. 14th Aug. 1782.
1	7	4	WbyN.	North.		Fresh gales and fair.
2	7	4				
3	7	5	W½N.			
4	7	5				
5	7	4				
6	7	4	WNW.			The Bill of Portland NW.
7	7	6				
8	7	3				
9	6	6				
10	6	4				
11	6	2				
12	6					Do. weather.
1	6	6				
2	5	4				
3	5	2				
4	5		WNW½N.	NbyE.		The Start WNW½ W. 5 or 6 leagues.
5	4	2				
6	5	4				
7	6					
8	6	4				
9	6	4				
10	6	5		N½E.		
11	6	5				
12	6	5				Lizard NW.

The LOG BOARD.

H	K	F	Courses	Winds	Leeway.	Remarks, &c. Thurs. 15th August, 1782.
1	6	4	WSW.	North	½	Brisk winds and cloudy
2	6	4				
3	6	2	SWbyW	NNW:		
4	6	—				
5	5	6	SW.	NW		Moderate and fair, at 5 the Liz. bore NE. dist. 5 leagues, from which we took our departure.
6	5	4				
7	4	4				
8	4	—				
9	3	5			1	
10	3	2				
11	3	6				
12	4	2				Do. weather, spoke the the Brig Kensington, bound to Oporto, J. Wheeler, Master.
1	5	—				
2	5	2			½	
3	5	—				
4	5	4				
5	6	—				
6	6	4				
7	6	6			0	Brisk winds & cloudy.
8	7	—				
9	7	2				
10	7	—				Variation 2 Points West.
11	7	4				
12	7	4				

Course	Dist. in Miles	Diff. Lat.	Dep.	Lat. in per account	Lat. in p. obs.	Long. in	Mer. Dist.	Bearings and Dist. at Noon.
S17°55W	125.8	119.6	38.7	° ′ 47.58N	47.58	° ′ 6.14W	38.7	Usha. N56°.19′ Dist. 55.89 miles.

TRAVERSE

TRAVERSE TABLE.

Courses.	Points.	Dist.	Northing.	Southing.	Easting.	Westing.
SbyW½W.	1½	35		33.5		10.2
SbyW.	1	20		19.6		3.9
SbyW½W.	1½	28		26.8		8.1
SSW.	2	43		39.7		16.5
				119.6		38.7

As d. lat. = 119.6 = 7.92227
.. radius = 90° = 10.00000
: : dep. = 38.7 = 1.58771
.. t. co. = 17.55 = 9.50998

As s. co. = 17°.55′ = 0.51197
.. dep. = 38′.7 = 1.58777
: : radius = 90 = 10.
.. dist. = 125.8 = 2.09968

Yest. lat. = 49°.58′ N = 3471
to-day's di. = 2 .00 S
ship's la. in = 47.58 N = 3289
M. D. lat. 182

Radius = 90 = 0.00000
.. M.D. lat. = 182 = 2.26007
: : t. cour. = 17.56 = 9.50962
.. dif. lon. = 58.8 = 1.76969

Yesterday's long. 5°.15′ W.
To-day's diff. long. 0 .59 W.
Ship's long. in......... 6 .14 W.

To find the Bearing and Distance of Ushant, it is thus

Ship's lat. 47°.58′ N = 3289
Ushant's lat. 48 .29 N = 3335
P. D. lat. 0 .31 = M.D. 46′

Ship's long. 6°.14′ W.
Ushant's long. 5 . 5 W.
1 . 9
60
Diff. long. 69 miles.

As m.d. lat. = 46 = 8.33724
.. radius = 90° = 10.00000
: : dif. lon. = 69 = 1.83885
.. t. bear. = 56.19 = 10.17609

As radius = 90° = 0.00000
.. P.D. lat. = 31 = 1.49136
: : se. bear. = 56.19 = 10.25602
.. dist. = 55.89 = 1.74738

The LOG BOARD.

H	K	F	Courses	Winds	Lee-way.	Remarks, &c. Friday, 16th Aug. 1782.
1	7	6	SW.	NW.	0	Brisk winds and clear.
2	7	4				
3	7	6				
4	7	4				
5	7	4				
6	7	4	——	NWbyW	½	
7	7	4				
8	7	2				
9	7	2				
10	7	2				
11	7	3				
12	7	2	——	——	——	Do. and cloudy.
1	7	—				
2	7	—				
3	6	6				
4	6	6				
5	6	6				
6	6	4		WNW.		
7	6	4	——	——	1	
8	6	—				
9	6	2				
10	6	—	——	——	——	Moderate and cloudy.
11	5	4				
12	5	—		——		Variation 2 Points W.

Course.	Dist. in miles.	Diff. Lat.	Dep.	Lat. in per ac.	Lat. in per ob.	Lon. in	Mer. Dist.	Bearings and Dist. at noon.
S. 17° W.	166.6	159.3	48.7	45° 19'		7.25 W	87.4 W	Cape Ortagal S. 6.12 W. Dist. 92.54 miles.

TRA-

TRAVERSE TABLE.

Courses corrected.	Points.	Dist.	Northing.	Southing.	Easting.	Westing.
SSW.	2	39		36.0		14.9
S by W½W.	1½	93		83.0		27.0
S by W.	1	35		34.3		6.8
				159.3		48.7

As d. lat. =159′.3 = 7.79778	As ſ. co. =17°. = 3.53407
.. radius =90°. =10.00000	.. dep. =48.7 = 1.68753
:: dep. =48.7 = 1.68753	: : radius =90°. =10.00000
.. t. co. =17° = 9.48531	.. diſt. =166.6 = 2.22160

Yeſterd. lat. 47°.58′ N =3289	As radius =90°. =0.00000
to-day's d. lat. 2 .39 S. =	.. M.D. la. =232 =2.36549
Ship's lat. in 45 .19 N =3057	: : t. co. =17°. =9.48534
M. D. lat. 232	.. d. long. =70′.93 =1.85083

Yeſterday's longitude 6°.14′ W.
This day's diff. long. 1 .11 W.
Ship's long. in 7 .25 W.

Find the Bearing and Distance of Cape Ortagal.

Ship's lat. 45°.19′ N. =3057	Ship's long. 7°.25′ W.
Cape's lat. 43 .47 N. =2928	Cape's long. 7 .39 W.
P.D. lat. 1 .32 M.D. lat. 129	Diff. long. 0 .14 W.

As M.D. lat. =129 = 7.88941	As radius =90°. = 0.00000
.. radius =90° =10.00000	.. P.D. la. =92 = 1.96379
: : diff. lon. =14 = 1.14613	: : ſe. bear. =6°.12′ =10.00255
.. t. bear. =6°.12′ = 9.03554	.. diſt. =92.54 = 1.96634

The

The LOG BOARD.

H	K	F	Courses.	Winds.	Lee-way.	Remarks, &c. Saturday 17th August, 1782.
1	5	4	WSW.	NW.	1	Moderate, clear.
2	5	2				
3	5	2				
4	5					
5	4	6	West.	NNW.	$1\frac{1}{2}$	
6	4	6				
7	4	4				
8	4	6				
9	4	4				
10	4	2				
11	4	2				
12	4	6				Do. weather.
1	4	6				
2	4	6		North.	1	
3	5					
4	5	2				
5	5	2				
6	5					
7	5	2				
8	5	4				
9	5	4				People employed setting
10	6				$\frac{1}{2}$	up the rigging, strong
11	6	6				breezes and cloudy.
12	7					Variation $1\frac{1}{2}$ point west.

Course.	Dist.	Diff. lat.	Dep.	Lat. in per account	Lat. in p. obs.	Long. in	Merid. Dist.	Bearings and d. at Noon.
S57°.8' W	123.5	67	103.7	44°.12N	44.12 N.	9.50W	119.1 W.	C. Fin. S16°.34'½ d. 83.47 miles.

TRA-

TRAVERSE TABLE.

Courses.	Points.	Dist.	Northing.	Southing.	Easting.	Westing.
SWbyS$\frac{1}{2}$W.	$3\frac{1}{2}$	21	——	16.2	——	13.3
SWbyW.	5	42	——	23.3	——	34.9
SWbyW$\frac{1}{2}$W	$5\frac{1}{2}$	42	——	19.8	——	37.0
WSW.	6	20	——	7.7	——	18.5
				67.0		103.7

As diff. lat. = 67′ = 8.17393	As ſ. co. 57°.8′ = 0.07575
.. radius = 90° = 10.00000	.. depart. 103.7 = 2.01578
:: dep. = 103′ 7 = 2.01578	.. radius 90° = 10.00000
.. t. co. = 57°.8′ = 10.18971	.. diſt. 123.5 = 1.09153

Yeſterd. lat. 45°.19′ N. = 3057	As rad. = 90° = 0.00000
this day's d. l. 1 . 7 S. =	.. m. d. la. = 94′ = 1.97313
ſhip's la. in 44 .12 N. = 2963	:: t. courſe = 57.8 = 10.18970
M. D. lat. 94	.. d. lon. = 145.5 = 1.16283

Yeſterday's long. = 7°.25′ W.
This day's diff. lon. = 2 .25 W.
Ship's long. in = 9 .50 W.

Find the BEARING and DISTANCE of Cape Finiſter.

Ship's lat. 44°.12′ N. = 2963	Ship's long. 9°.50′ W.
Cape's lat. 42 .52 N. = 2852	Cape's long. 9 .17 W.
P. D. lat. 1.20 M. D. lat. 111	Diff. long. 33 W.

As M. D. lat. = 111 = 7.95468	As radius = 90° = 0.00000
.. radius = 90° = 10.00000	.. P. D. la. = 80′ = 1.90309
:: diff. long. = 33 = 1.51851	:: ſe. bear. = 16°.34′ = 10.01841
.. t. bear. = 16.34 = 9.47319	.. diſt. = 83.47 = 1.92150

The

The LOG BOARD.

H	K	F	Courses	Winds	Lee-way.	Remarks, &c. Sunday, 18 Aug. 1782.
1	7	5	WSW.	NW.	½	Strong gales, and rain.
2	7	5				
3	7	5				
4	8					
5	8	2				
6	8					Do. weather, and cloudy.
7	8					
8	8	2				
9	8	2				Do. weather, with rain, thunder, and lightning; lay too under reef mainsail upon the larboard tack.
10	8	4				
11	8	2				
12	—		up NWbyW. off North Drift 1½ per hour.	SW.		
1	—					
2	—					
3	—				6	Strong gales and cloudy; lay too under reef mainsail upon the starboard tack.
4	—					
5	—					
6	—					
7	—		upSEbySoff ESE drift 1 mile per h.			
8	—				5	Fresh gales and cloudy; set more sail.
9	—					
10	6	2	SW.	WNW	2	Do. weather and fair.
11	6	2				
12	6	3				Variation 1½ W.

Course.	Dist.	Diff. Lat.	Dep.	Lat. in p. acco.	Lat. in p. obs.	Lon. in	Meri. Dist.	Bearings & dist. at Noon.
S.49W.	85	56	64.2	43°.02N	43°.16N	11°.20	255.5 W.	Cape St. Vincent S15°.43′E. dist. 388.6miles.

TRA-

TRAVERSE TABLE.

Courses corrected.	Points.	Dist.	Northing.	Southing.	Easting.	Westing.
SW.	4	89		62.9		62.9
NNE.	2	105	9.7		4.5	
NEbyE.	5	3	1.7		2.0	
S½W.	½	19		18.9		1.9
			11.4	81.8	6.5	64.8
				11.4		6.5
				70.4		58.3

As d. lat. =70.4 = 8.15243	As s. co. =39°.38′= 0.19427
.. radius =90° =10.00000	.. depart. =58.03= 1.76567
:: depart. =58.3 = 1.76567	:: radius =90 =10.00000
.. t. cou. =39.38 = 9.91810	.. dist. =91′.4= 1.96099
Yesterd.'s la. =44.12N=2963	As rad. =90 = 0.00000
To-day's d. la. = 1.10S=	.. M.D.la. =97′ = 1.98677
this day's l. in =43.02N=2866	:: t. cou. =39°.38= 9.91816
M. D. lat. = 97	.. di. lon. =80.34= 1.90493

N. B. The lat. by acc. and that of obs. not agreeing, I correct this day's work by case 2d, page 120, which I find as follows, viz. true course S.49°.0 W. dist. 85 miles, and true diff. long. 89.8 miles.

Yesterday's long.	9°.50′ W.
This day's diff. long.	1 .30 W.
Ship's long. in	11 .20 W.

To find the Bearing and Distance of Cape St. Vincent.

Ship's lat.	43°.16′ N=2885	Ship's long.	11°.20′ West
C.St.Vin.lat.	37 .02 N=2395	Cape's long.	9 .02 West
P.D. lat.	6 14	M.D.la. 490	2 18
	60		60
	374		138

As M.D. la. =490 = 7.30970	As radius =90°= 0.00000
.. radius =90° =10.00000	.. P.D. lat. =374= 2.57287
:: di. lon. =138 = 2.13988	:: se.bear. =15.43=10.01655
.. t. bear. =15°.43=9.44958	.. dist. =388.6 = 2.58942

The LOG BOARD.

H	K	F	Courses.	Winds.	Lee-way.	Remarks, &c. Monday 19th August, 1782.
1	6	3	SW.	WNW.	2¼	These 24 hours, fresh gales and fine weather.
2	6	2				
3	6	5				
4	[illegible]	[illegible]				
5	6	6				
6	5	[illegible]				
7	[illegible]	[illegible]				
8	7	[illegible]		NW by W.	1	
9	7	2				
10	7	4				
11	7	[illegible]			½	
12	6	[illegible]				
1	8	[illegible]				
2	8	2				
3	8	2				
4	8	3				
5	8	2				
6	8	2				
7	8	[illegible]				
8	8	[illegible]				People employed setting up the rigging.
9	8	[illegible]				
10	8	2				
11	8	[illegible]				Variation 1¼ points west.
12	8	2				

Course.	Dist. in miles.	Diff. lat.	Dep.	Lat. in per ac.	Lat. in per ob.	Long. in	Mer. Dist.	Bearings & dist. at Noon.
				° ′	° ′	°		C. St. Vi. S 40°.
[illegible]	[illegible]	[illegible]	[illegible]	40.14N	40.23	122.39W	324.7	24′E. dist. 62.6

The TRAVERSE TABLE.

Courses corrected.	Points.	Dist.	Northing.	Southing.	Easting.	Westing.
S by W.	1	47		46.1		9.2
S by W ½ W.	1½	22		21.1		6.4
SSW.	2	114		105.3		43.6
				172.5		59.2

As d. lat. = 172.5 = 7.76321	As l. co. = 18°.56 = 0.4[illegible]
: radius = 90°. = 10.00000	. . dep. = 59.2 = 1.77[illegible]
:: dep. = 59.2 = 1.77232	: : radius = 90°. = 10.[illegible]
. . t. co. = 18°56′ = 9.53553	. . dist. = 182.5 = 2.[illegible]

Yesterd. lat. 43°.16′ N = 2885	As radius = 90°. = [illegible]
To-day's d. lat. 2 .52 S.	. . M. D. la. = 231 = [illegible]
Ship's lat. in 40 .24 N = 2654	: : t. co. = 18°.56′ = 9.[illegible]
M. D. lat. 231	. . d. long. = 79′, 24 = 1.[illegible]

Yesterday's longitude 11°.20′ W.
This day's diff. long. 1 .19 W.
Ship's long. in 12 .39 W.

Find the Bearing and Distance of Cape St. Vincent.

Ship's lat. 40°.23′ N. = 2653	Ship's long. 12°.39′ W.
Cape's lat. 37 .02 N. = 2395	Cape's long. 9 . 2 W.
3 .21 M. D. lat. 258	3 .37 W.
	60
	diff. long. 217 miles.

As M. D. lat. = 258 = 7.58838	As radius = 90°. = 0.00000
. . radius = 90° = 10.00000	. . P. D. la. = 201 = 2.30320
: : diff. lon. = 217 = 2.33646	: : lc. bear. = 40.04′ = 10.11617
. . t. bear. = 40°.4′ = 9.92484	. . dist. = 262.6 = 2.[illegible]

The

The LOG BOARD.

H	K.	F.	Courses	Winds.	Lee-way.	Remarks, &c. Tuesday, 20th Aug. 1782.
1	8	6	SSW.	WNW	$\frac{1}{4}$	Strong gales and fair.
2	8	6				
3	8	6				
4	9	—				
5	9	—				
6	9	—				
7	9	2				
8	9	—				
9	9	2				
10	9	1				
11	9	—				
12	9	—				Do. weather and cloudy,
1	9	2				
2	9	—		WbyN.		
3	8	6			$\frac{1}{2}$	
4	8	6				
5	8	6				
6	8	4				
7	8	—				
8	8	—				
9	7	4			$\frac{3}{4}$	Fresh gales and cloudy.
10	7	2				
11	7	1				Do. weather:
12	7	—				Variation $1\frac{1}{4}$ point W.

Course.	Dist. in miles	Diff. lat.	Dep.	Lat. in per account	Lat. in p. obs.	Long. in	Merid. Dist.	Bearings and d. at Noon.
[illegible] W.	206.2	205.3	14.8	36°.59'N.		12.58N	329.3	C.St.V. N89°02 E. d: 177. 5m.

TRA-

TRAVERSE TABLE.

Courses.	Points.	Dist.	Northing.	Southing.	Easting.	Westing.
S$\frac{1}{2}$W.	$\frac{1}{2}$	126		125.4		12.3
S$\frac{1}{4}$W.	$\frac{1}{4}$	51		50.9		2.5
S.	0	29		29.0		0.0
				205.3		14.8

As di. lat. = 205.3 = 7.68656	As f. co. = 4°.7′ = 1.14395
. . radius = 90° = 10.00000	. . depart. = 14.8 = 1.17026
: : depart. = 14.8 = 1.17026	: : radius = 90° = 10.00000
. . t. cour. = 4°.7′ = 8.85682	. . dist. = 206.2 = 2.31421

M. parts.

Yesterd. lat. 40°.24′ N. = 2654	As rad. = 90° = 0.00000
to-day's d.l. = 3 .25 S. =	. . m. d. la. = 263 = 2.41996
ship's la. in = 36 .59 N. = 2391	: : t. course = 4°.7′ = 8.85717
M. D. lat. 263	. . diff. lon. = 18.93 = 1.27713

Yesterday's long. 12°.39 W.
This day's diff. lon. 0 .19 W.
Ship's long. in 12 .58 W.

Find the Bearing and Distance of Cape St. Vincent.

Ship's lat. = 36°.59′ N. = 2391	Ship's long. 12°.58 W.
Cape's lat. = 37 .02 N. = 2395	Cape's long. 9 . 2 W.
P. D. lat. 3 M. D. lat. 4	3 .56
	60
	Diff. long. 236 miles.

As m. d. lat. = 4′ = 9.39794	As radius = 90° = 0.00000
. . radius = 90° = 10.00000	. . P. D. la. = 3′ = 0.47712
: : diff. long. = 236 = 2.37291	: : fe. bear. = 89°.02 = 11.77206
. . t. bear. = 89°.02 = 11.77085	. . dist. = 177.5 = 2.24918

 The

The LOG BOARD.

H	K.	F.	Courses	Winds.	Lee-way.	Remarks, &c. Wednesd, 21st of August, 1782.
1	7	8	SE.	SW.	$\frac{1}{4}$	Fresh gales and hazy.
2	7	6				
3	7	4				
4	7	3				
5	7	2				
6	7	3				Fresh gales, with rain.
7	7	4				
8	7	4				
9	7	—				
10	7	4				
11	7	3				
12	7	2				Fresh gales and cloudy.
1	7	4	ESE.	SSW.	$\frac{1}{2}$	
2	7	6				
3	8	—				
4	8	1				Strong gales and fair.
5	8	1				
6	8	2				
7	8	2				
8	8	—				Gave John Jones 1 dozen for drunkenness.
9	8	—				
10	8	4				Do. weather.
11	8	6				
12	9	—				Variation 1 point W.

Course.	Dist.	Diff. Lat.	Dep.	Lat. in p. acco.	Lat. in p. obs.	Lon. in	Meri. Dist.	Bearings & dist. at Noon.
S. 72.30 E.	186.3	59	176E	36°.11′N	36°.02N	9°.20′	153′.3 W.	Gibraltar N.88.19E. dist. 204.2 miles.

TRAVERSE TABLE.

Courses corrected.	Points.	Dist.	Northing.	Southing.	Easting.	Westing.
SEbyE¾E.	5¼	89		38.1	80.5	
EbyS¼E.	7¼	100		0.8	99.5	
				47.9	180.0	

As diff. lat. = 47.9 = 8.31885	As s. cou. = 75°.4′ = 0.01492
: radius = 90° = 10.00000	: depart. = 188 = 2.25527
:: depart. = 180 = 2.25527	:: radius = 90 = 10.00000
: t. cou. = 75°.4′ = 2.57412	: dist. = 186.3 = 2.27019
Yesterd.'s la. = 36°.59N = 2391	As rad. = 90 = 0.00000
To-day's d. la. = 0.48S =	: MD. la. = 59′ = 1.77085
Ship's la. in = 36.11N = 2332	:: t. cou. = 75°.4′ = 10.57387
M. D. lat. 59	: di. lon. = 221.8 = 2.34472

N. B. The lat. by acc. and that by obs. not agreeing, I correct this day's work by inspection case 3d, page 122, which I find as follows, viz. the true course S. 71°. 30 E. and true diff. long. 218 miles E.

Yesterday's long.	12°.58	W.
This day's diff. long.	3 .38	E.
Ship's long. in	9 .20	W.

To find the Bearing and Distance of Gibraltar.

Ship's lat. = 36°.00′N = 2318	Ship's long. = 9°.20′ West
Gib. lat. = 36 . 6 N = 2325	Gibraltar's long. = 5 .22 West
P.D. lat. 6 M.D. la. 7	3 58
	60
	238

As MD. la. = 7 = 9.15480	As radius = 90° = 0.00000
: radius = 90° = 10.00000	: PD. lat. = 6′ = 0.77815
:: di. lon. = 238 = 2.37658	:: se. bear. = 88°.19 = 11.53201
: t. bear. = 88°.19 = 11.53138	: dist. = 204.2 = 2,31016

The

The LOG BOARD.

H	K.	F.	Courses	Winds.	Lee-way.	Remarks, &c. Thursday, 22d August, 1782.
1	9	—	ESE.	South	1	Strong gales and fair.
2	9	—				
3	8	6				
4	8	6				
5	8	6				
6	8	6				
7	8	4				Strong gales and hazy.
8	8	4				
9	8	6				
10	8	4				
11	8	3				Do. weather, with dryzling rain.
12	8	2				
1	8	3				
2	8	2				
3	8	2				
4	8	—				
5	8	—				
6	8	—				
7	8	2				cleared up a little, observed Cape Spartel bearing S by E. 3 or 4 leagues.
8	8	—				
9	8	—				
10	8	—				
11	8	—				
12						Came to anchor in Gibraltar Bay, in 5 fathoms, between the New & Old Mole, Old Mole NNE. New Mole SSE.

INSTRUC-

INSTRUCTIONS

TO

WRITE A JOURNAL,

FROM THE

LOG BOOK, OR LOG BOARD.

First, mention is made of the Year, Month and Day of the Week in one Column; Day of the Month in another Column; Winds in another Column, &c. &c. as is ruled in all Journals which are to be purchased at most Stationers; and for a clear demonstration of Writing a Journal from a Sea Log, you will observe the following, which is done from the Log of the preceding Voyage.

A JOURNAL

OF THE

Proceedings of his Majesty's Ship the CUMBERLAND, *Edward Howorth*, Esq; Commander, by *J. Diligent*, Master, commencing the 13th of *August*, 1782.

month, year, & days.	month day.	Winds.	Courses.	Dist. in mils.	Lat. in	Lon. in	Bearings and Distance at Noon.
Aug. 1782. Tues.	th 13	North. NbyE.	———	———			Bembridge p. NWbyW 4 leagues.
Wedn.	th 14	North. NbyE. N½E.					The Lizard NW.
Thurs.	th 15	North. NNW. NW.	S17°.55′W	126	47.58N.	6.14W.	Ushant N. 56°.19′ E. dist. 55.89 miles.
Friday	th 16	NW. NWbW NNW.	S17°. 0′W	167	45°.19′N.	7°.25′W.	C. Ortagal, S. 6°.12′ W. d. 92.54 mi.
Saturd.	th 17	NW. NNW. North.	S57°. 8′W	124	44.12N.	9.50W	C. Finisterre, S. 16°.34′ E. d. 82.23 mil.
Sund.	th 18	NW. SW. WNW.	S49°. W.	85	43°.16′N.	11°.20′W.	C. St. Vinc. S. 15°.43′E. d. 388.6 mil.
Mond.	th 19	WNW. NWbW	S18°.56′W	183	40°.23′ N.	12°.39′W.	C. St. Vinc. S. 40°.04′ E. d. 263 miles.
Tuesd.	th 20	WNW. WbyN.	S 4° 7′W.	206	36°.59′ N.	12°.58′W.	C. St. Vinc. N. 89°.02′ E. d. 177.5 mil.
Wedn.	st 21	SW. SSW.	S71°.30′ E.	186	36°. 0′N.	9°.20′W.	Gibraltar, N. 88°.19′ E. d. 204.2 miles
Thurs.	d 22	ESE.					Old Mole NNE. New Mole SSE.

REMARKS, &c.

First and middle parts moderate and fair, latter fresh gales and squally; at 3 P.M. hove short; at 5 weighed and sailed; at 9 unbent the cables, and stowed the anchors at 7 A.M. Beachy-head North 7 miles.

Fresh gales and fair at 6 P.M. the Bill of Portland NW: at 4 A.M. the Start WNW½W. 5 or 6 leagues.

First and latter parts brisk winds and cloudy, middle moderate and fair; at 5 P.M. the Lizard bore NE. distance 5 leagues; at midnight spoke with the brig Kingston, bound to Oporto, John Wheeler, Master.

First part fresh gales and clear, middle cloudy, latter moderate and cloudy.

First and middle parts moderate and clear, latter strong breezes and cloudy; at 9 A.M. people employed in setting up the rigging.

First part strong gales and fair, middle, rain, thunder, and lightning, latter fresh gales and cloudy; lay too from midnight till 9 A.M. at 9 A.M. set more sail.

These 24 hours fresh gales and fine weather; at 9 A.M. people employed in setting up the rigging.

First part strong gales and fair, middle and latter fresh gales and cloudy.

First part fresh gales and hazy, middle cloudy, latter strong gales and fair; at 8 A.M. punished John Jones, with one dozen lashes for drunkenness.

First part strong gales and fair, middle rain, latter fair; at 7 A.M. Cape Spartel SbyE. 3 or 4 leagues; at noon came to anchor in Gibraltar Bay in 5 fathoms.

CASE I.

To find the declination for any particular hour, by the table of the ſun's declination for the meridian of London.

RULE.

If A. M. take the difference between the preceding noon and noon of the day.—If P.M. you muſt uſe the difference between the noon of the day and following day.

And ſay as 24 hours are to that difference, ſo are the hours and minutes elapſed ſince the laſt noon to a fourth number, which being added or ſubtracted to the degrees and minutes againſt the noon of the day or preceding noon, gives the declination as required.

N. B. If the declination be increaſing, you add; but if decreaſing, you ſubtract.

EXAMPLE.

Let it be required to find the ſun's declination for the 15th of May, 1782, at 5 in the morning, and at 5 in the evening.

For the morning.

14th May, dec.	18°.44′
15th Do.	18 .58
Difference	00 .14

As 24 hours . . 14′ : : 17 hours . . 10′ nearly.

14th May, dec.	18°.44′
Difference	00 .10
Morning's dec.	18 .54

For

For the Evening.

15th May, ... 18°.58′
16th Do. .... 19 .12

00 .14

As 24 hours . . 14′ : : 5 hours . . 3′ nearly.

15th May dec. 18°.58′
Difference..........00 .03

Evening's dec. 19 .01

Anſ. The ſun's declination the 15th of May, 1782, at 5 in the morning, was 18°.54′, and at 5 in the evening, it was 19°.01′.

CASE II.

To find the ſun's dec. for any particular hour, by the table of ſun's dec. to anſwer any meridian.

RULE.

Divide the degrees of longitude by 15, and if you are weſt longitude the time it gives muſt be added to the time you want to find the dec. for, but if eaſt longitude, ſubtracted, having then found the true time at London, proceed as directed in Caſe I.

EXAMPLE.

Let it be required to find the ſun's declination for the 15th of Sept. 1785, at 7 in the morning, and at 7 in the evening, in longitude 45 degrees Weſt?

15)45(3
45

Having

Having divided the degrees of longitude by 15, I find the quotient 3 hours, to which I add 7 hours (it being west longitude) gives 10 hours the time at London; then I proceed with 10 hours as in Case I.

For the Morning.

14th Sept. dec.	3°.12′
15th ditto	2.48
Difference	0.24

As 24 hours .. 24′ :: 22 hours .. 22′.

14th Sept. dec.	3°.12′
Difference	22
Morning's dec.	2.50

For the Evening.

15th Sept. dec.	2°.48′
16th ditto	2.25
Difference	0.23

As 24 hours .. 23′ :: 10 hours .. 10′ nearly.

15th Sept. dec.	2°.48′
Difference	0.10
Evening's dec.	2.38

Ans. The sun's declination the 15th of Sept. 1785, in longitude 45 degrees west, in the morning will be 2°.50′, and at 7 in the evening 2°.38′.

N. B. Should you want to know the sun or moon's semidiameters, or moon's horizontal parallax at any hour in any longitude, it is done from the Nautical Almanack in like manner as above.

The

A TABLE of the SUN'S DECLINATION for the YEARS 1781, 1785, 1789, 1793, 1797.

First after LEAP YEAR.

Days.	Jan.	Feb.	Mar.	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
	South	South	South	Nor.	Nor.	Nor.	Nor.	Nor.	Nor.	South	South	South
	D. M.	D. M.	D. M.	D. M.	D. M.	D. M.	D. M.	D. M.	D. M.	D. M.	D. M.	D. M.
1	22 58	16 54	7 19	4 48	15 16	22 9	23 6	17 54	8 5	3 26	14 40	21 56
2	22 53	16 37	6 56	5 11	15 34	22 17	23 2	17 39	7 43	3 49	14 59	22 5
3	22 46	16 19	6 33	5 34	15 52	22 24	22 57	17 23	7 21	4 12	15 17	22 14
4	22 40	16 1	6 10	5 57	16 9	22 31	22 52	17 7	6 59	4 35	15 36	22 22
5	22 33	15 43	5 47	6 19	16 26	22 38	22 46	16 51	6 37	4 58	15 54	22 29
6	22 26	15 24	5 24	6 42	16 43	22 44	22 40	16 34	6 14	5 22	16 12	22 36
7	22 18	15 5	5 0	7 5	17 0	22 50	22 33	16 18	5 52	5 45	16 30	22 43
8	22 10	14 46	4 37	7 27	17 16	22 55	22 27	16 1	5 29	6 8	16 47	22 49
9	22 1	14 27	4 14	7 49	17 32	23 0	22 19	15 43	5 6	6 30	17 4	22 55
10	21 52	14 7	3 50	8 11	17 47	23 5	22 12	15 26	4 44	6 53	17 21	23 0
11	21 42	13 47	3 27	8 33	18 3	23 9	22 4	15 8	4 21	7 16	17 38	23 5
12	21 33	13 27	3 3	8 55	18 18	23 13	21 56	14 50	3 58	7 38	17 54	23 10
13	21 22	13 7	2 39	9 17	18 33	23 16	21 47	14 31	3 35	8 1	18 10	23 14
14	21 11	12 47	2 16	9 38	18 47	23 19	21 38	14 13	3 12	8 23	18 26	23 17
15	21 0	12 26	1 52	10 0	19 1	23 21	21 28	13 54	2 48	8 46	18 41	23 20
16	20 49	12 5	1 28	10 21	19 15	23 24	21 18	13 35	2 25	9 8	18 56	23 23
17	20 37	11 44	1 5	10 42	19 29	23 25	21 8	13 16	2 2	9 30	19 11	23 25
18	20 24	11 23	0 41	11 3	19 42	23 27	20 58	12 56	1 39	9 52	19 25	23 26
19	20 12	11 2	0 17	11 24	19 55	23 28	20 47	12 37	1 16	10 13	19 39	23 27
20	19 59	10 40	N. 6	11 44	20 7	23 28	20 35	12 17	0 52	10 35	19 52	23 28
21	19 46	10 18	0 30	12 5	20 19	23 28	20 24	11 57	0 29	10 56	20 6	23 28
22	19 32	9 56	0 54	12 25	20 31	23 28	20 12	11 37	0 5	11 18	20 18	23 28
23	19 18	9 34	1 17	12 45	20 42	23 27	20 0	11 16	S. 18	11 39	20 31	23 27
24	19 3	9 12	1 41	13 4	20 54	23 26	19 47	10 56	0 42	12 0	20 42	23 26
25	18 48	8 50	2 4	13 24	21 4	23 24	19 34	10 35	1 5	12 20	20 55	23 24
26	18 32	8 27	2 27	13 43	21 15	23 22	19 21	10 14	1 29	12 41	21 6	23 22
27	18 17	8 5	2 52	14 52	21 25	23 20	19 7	9 53	1 52	13 1	21 17	23 19
28	18 1	7 42	3 15	14 21	21 34	23 17	18 53	9 32	2 15	13 21	21 27	23 16
29	17 45		3 38	14 40	21 44	23 14	18 39	9 10	2 39	13 41	21 37	23 13
30	17 28		4 2	14 58	21 53	23 10	18 24	8 49	3 2	14 1	21 47	23 9
31	17 11		4 25		22 1		18 10	8 27		14 20		23 4

A TABLE of the SUN'S DECLINATION for the YEARS 1782, 1786, 1790, 1794, 1798.

Each being the Second after LEAP YEAR.

Days.	Jan.	Feb.	Mar.	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
	South	South	South	Nor.	Nor.	Nor.	Nor.	Nor.	Nor.	South	South	South
	D.M.	D.M.	D.M.	D.M.	D.M.	D.M.	D.M.	D.M.	D.M.	D.M.	D.M.	D.M.
1	22 59	16 58	7 25	4 42	15 12	22 7	23 7	17 58	8 10	3 20	14 35	21 54
2	22 54	16 41	7 2	5 5	15 30	22 15	23 3	17 43	7 49	3 43	14 54	22 3
3	22 48	16 23	6 39	5 28	15 47	22 23	22 58	17 27	7 26	4 7	15 13	22 12
4	22 42	16 5	6 16	5 51	16 5	22 30	22 53	17 11	7 4	4 30	15 32	22 20
5	22 35	15 47	5 53	6 14	16 22	22 36	22 47	16 55	6 42	4 53	15 50	22 27
6	22 27	15 29	5 29	6 37	16 39	22 43	22 41	16 38	6 20	5 16	16 8	22 35
7	22 20	15 10	5 6	6 59	16 56	22 48	22 35	16 23	5 57	5 39	16 26	22 41
8	22 12	14 51	4 43	7 21	17 12	22 54	22 28	16 5	5 34	6 2	16 43	22 48
9	22 3	14 32	4 19	7 44	17 28	22 59	22 21	15 47	5 12	6 25	17 0	22 54
10	21 54	14 12	3 56	8 6	17 44	23 4	22 14	15 30	4 49	6 48	17 17	22 59
11	21 45	13 52	3 32	8 28	17 59	23 8	22 6	15 12	4 26	7 11	17 34	23 4
12	21 35	13 32	3 9	8 50	18 14	23 12	21 58	14 54	4 3	7 33	17 50	23 8
13	21 25	13 12	2 45	9 12	18 29	23 15	21 49	14 36	3 40	7 56	18 6	23 12
14	21 14	12 52	2 21	9 33	18 44	23 18	21 40	14 17	3 17	8 18	18 22	23 16
15	21 3	12 31	1 58	9 55	18 58	23 21	21 31	13 58	2 54	8 40	18 37	23 20
16	20 52	12 10	1 34	10 16	19 12	23 23	21 21	13 40	2 31	9 3	18 52	23 22
17	20 40	11 49	1 10	10 37	19 25	23 25	21 11	13 20	2 7	9 24	19 7	23 24
18	20 28	11 28	0 47	10 58	19 39	23 26	21 0	13 1	1 44	9 47	19 22	23 26
19	20 15	11 7	0 23	11 19	19 52	23 27	20 49	12 41	1 21	10 8	19 36	23 27
20	20 2	10 45	N. 1	11 39	20 4	23 28	20 38	12 22	0 57	10 30	19 49	23 28
21	19 48	10 23	0 24	12 0	20 16	23 28	20 27	12 2	0 34	10 51	20 2	23 28
22	19 35	10 2	0 48	12 20	20 28	23 28	20 15	11 41	0 11	11 13	20 15	23 28
23	19 21	9 40	1 12	12 40	20 40	23 27	20 3	11 21	S. 13	11 34	20 28	23 27
24	19 6	9 17	1 25	13 0	20 51	23 26	19 50	11 1	0 36	11 55	20 40	23 26
25	18 51	8 55	1 59	13 19	21 2	23 25	19 37	10 40	1 0	12 15	20 52	23 25
26	18 36	8 33	2 22	13 39	21 12	23 23	19 24	10 19	1 23	12 36	21 3	23 23
27	18 21	8 10	2 46	13 58	21 22	23 21	19 10	9 58	1 46	12 56	21 14	23 20
28	18 5	7 48	3 9	14 17	21 32	23 18	18 57	9 37	2 10	13 17	21 25	23 17
29	17 49		3 33	14 35	21 41	23 15	18 42	9 15	2 33	13 36	21 35	23 14
30	17 32		3 56	14 54	21 50	23 11	18 28	8 54	2 57	13 56	21 45	23 10
31	17 15		4 19		21 59		18 13	8 32		14 16		23 5

A TABLE of the SUN's DECLINATION for the YEARS 1783, 1787, 1791, 1795, 1799.

Third after LEAP YEAR.

Days.	Jan.	Feb.	Mar.	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
	South	South	South	Nor.	Nor.	Nor.	Nor.	Nor.	Nor.	South	South	South
	D. M.	D. M.	D. M.	D. M.	D. M.	D. M.	D. M.	D. M.	D. M.	D. M.	D. M.	D. M.
1	23 0	17 2	7 30	4 36	15 8	22 5	23 8	18 2	8 16	3 14	14 30	21 53
2	22 55	16 45	7 7	5 0	15 26	22 13	23 4	17 46	7 54	3 38	14 50	22 1
3	22 49	16 28	6 44	5 23	15 43	22 21	22 59	17 31	7 32	4 1	15 8	22 10
4	22 43	16 10	6 21	5 46	16 1	22 28	22 54	17 15	7 10	4 24	15 27	22 18
5	22 36	15 51	5 58	6 8	16 18	22 35	22 49	16 59	6 47	4 48	15 45	22 26
6	22 29	15 33	5 35	6 31	16 35	22 41	22 43	16 42	6 25	5 11	16 4	22 33
7	22 22	15 14	5 12	6 54	16 52	22 47	22 37	16 26	6 2	5 34	16 21	22 40
8	22 14	15 55	4 48	7 16	17 8	22 53	22 30	16 9	5 40	5 57	16 39	22 46
9	22 5	14 36	4 25	7 39	17 24	22 58	22 23	15 51	5 17	6 20	16 56	22 52
10	21 56	14 17	4 1	8 1	17 40	23 3	22 16	15 34	4 54	6 42	17 13	22 58
11	21 48	13 57	3 38	8 23	17 55	23 7	22 8	15 16	4 32	7 5	17 30	23 3
12	21 37	13 37	3 14	8 43	18 11	23 11	21 0	14 58	4 9	7 28	17 46	23 7
13	21 27	13 17	2 51	9 7	18 26	23 15	21 51	14 40	3 46	7 50	18 2	23 11
14	21 17	12 57	2 27	9 28	18 40	23 18	21 42	14 22	3 23	8 13	18 18	23 15
15	21 6	12 36	2 3	9 50	18 54	23 20	21 33	14 3	3 0	8 35	18 34	23 19
16	20 54	12 15	1 40	10 11	19 8	23 23	21 23	13 44	2 36	8 57	18 49	23 21
17	20 43	11 54	1 16	10 32	19 22	23 25	21 13	13 25	2 13	9 19	19 4	23 24
18	20 21	11 33	0 52	10 53	19 35	23 26	21 3	13 6	1 50	9 41	19 18	23 25
19	20 18	11 12	0 29	11 14	19 48	23 27	20 52	12 46	1 27	10 3	19 32	23 27
20	20 5	10 50	0 5	11 34	20 1	23 28	20 41	12 26	1 3	10 25	19 46	23 28
21	19 52	10 29	N. 19	11 55	20 13	23 28	20 29	12 7	0 40	10 46	19 59	23 28
22	19 38	10 7	0 42	12 15	20 24	23 28	20 18	11 46	0 16	11 7	20 12	23 28
23	19 24	9 45	1 6	12 35	20 37	23 27	20 6	11 26	S. 7	11 29	20 25	23 28
24	19 0	9 23	1 30	12 55	20 48	23 27	19 53	11 6	0 31	11 50	20 37	23 27
25	18 55	9 1	1 53	13 15	20 59	23 25	19 40	10 45	0 54	12 10	20 49	23 25
26	18 40	8 38	2 17	13 34	21 10	23 23	19 27	10 24	1 17	12 31	21 1	23 23
27	18 24	8 16	2 40	13 53	21 20	23 21	19 14	10 3	1 41	12 51	21 12	23 21
28	18 9	7 53	3 4	14 12	21 30	23 18	19 0	9 42	2 4	13 12	21 22	23 18
29	17 53		3 27	14 31	21 39	23 15	18 46	9 20	2 28	13 32	21 33	23 14
30	17 36		3 50	14 49	21 48	23 12	18 31	8 59	2 51	13 52	21 43	23 11
31	17 19		4 14		21 57		18 17	8 37		14 11		23 6

A TABLE of the SUN'S DECLINATION for the YEARS 1784, 1788, 1792, 1796, 1800.

Each being LEAP YEAR.

Days.	Jan.	Feb.	Mar.	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
	South	South	South	Nor.	Nor.	Nor.	Nor.	Nor.	Nor.	South	South	South
	D.M.	D.M.	D.M.	D.M.	D.M.	D.M.	D.M.	D.M.	D.M.	D.M.	D.M.	D.M.
1	23 2	17 7	7 14	4 53	15 21	22 11	23 5	17 51	8 0	3 31	14 44	21 59
2	22 57	16 50	6 52	5 16	15 38	22 19	23 1	17 35	7 38	3 55	15 3	22 7
3	22 51	16 32	6 28	5 39	15 56	22 26	22 56	17 19	7 16	4 18	15 22	22 16
4	22 45	16 15	6 5	6 2	16 13	22 33	22 50	17 3	6 54	4 41	15 40	22 24
5	22 38	15 57	5 42	6 25	16 30	22 39	22 45	16 47	6 31	5 4	15 59	22 31
6	22 31	15 38	5 18	6 47	16 47	22 45	22 38	16 30	6 9	5 27	16 17	22 38
7	22 24	15 20	4 55	7 10	17 3	22 51	22 32	16 14	5 46	5 50	16 34	22 45
8	22 16	15 1	4 31	7 32	17 20	22 56	22 25	15 56	5 24	6 13	16 52	22 51
9	22 8	14 41	4 8	7 55	17 36	23 1	22 18	15 39	5 1	6 36	17 9	22 56
10	21 59	14 22	3 44	8 17	17 51	23 6	22 10	15 21	4 38	6 59	17 25	23 1
11	21 50	14 2	3 21	8 39	18 6	23 10	22 2	15 3	4 15	7 21	17 42	23 6
12	21 40	13 43	2 57	9 0	18 21	23 14	21 54	14 45	3 52	7 44	17 58	23 11
13	21 30	13 23	2 34	9 22	18 36	23 17	21 45	14 27	3 29	8 6	18 14	23 14
14	21 20	13 2	2 10	9 44	18 51	23 20	21 35	14 8	3 6	8 29	18 29	23 18
15	21 9	12 42	1 46	10 5	19 5	23 22	21 26	13 49	2 43	8 51	18 45	23 21
16	20 58	12 21	1 23	10 26	19 18	23 24	21 16	13 30	2 20	9 13	19 0	23 23
17	20 46	12 0	0 59	10 47	19 32	23 26	21 6	13 11	1 56	9 35	19 14	23 25
18	20 34	11 39	0 35	11 8	19 46	23 27	20 55	12 52	1 33	9 57	19 28	23 27
19	20 21	11 18	0 12	11 29	19 58	23 28	20 44	12 32	1 10	10 19	19 42	23 28
20	20 9	10 56	N. 12	11 49	20 10	23 28	20 33	12 12	0 46	10 40	19 56	23 28
21	19 55	10 35	0 34	12 9	20 22	23 28	20 21	11 52	0 23	11 2	20 9	23 28
22	19 42	10 13	0 59	12 30	20 34	23 28	20 9	11 32	S. 0	11 23	20 21	23 28
23	19 28	9 51	1 23	12 49	20 45	23 27	19 57	11 11	0 34	11 44	20 34	23 27
24	19 14	9 29	1 47	13 9	20 56	23 26	19 44	10 51	0 47	12 5	20 46	23 26
25	18 59	9 7	2 10	13 29	21 7	23 24	19 31	10 30	1 11	12 25	20 57	23 24
26	18 44	8 44	2 34	13 48	21 17	23 23	19 17	10 9	1 34	12 46	21 9	23 22
27	18 29	8 22	2 57	14 7	21 27	23 19	19 4	9 48	1 58	13 6	21 19	23 19
28	18 13	7 59	3 21	14 26	21 37	23 16	18 50	9 27	2 21	13 26	21 30	23 15
29	17 57	7 37	3 44	14 44	21 46	23 13	18 35	9 5	2 45	13 46	21 40	23 12
30	17 41		4 7	15 2	21 35	23 9	18 21	8 44	3 8	14 6	21 49	23 8
31	17 24		4 30		22 3		18 6	8 22		14 26		23 3

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To all Commanders and Officers in the Sea Line, or ſuch as are intended for a Naval Profeſſion.

J. BETTESWORTH and Co. have opened a Naval Academy in *Paradiſe-Row*, *Chelſea*, where all the various branches of ſcience and polite learning, neceſſary for the qualification of Sea Officers and accompliſhment of Young Gentlemen, are carefully and expeditiouſly taught by the moſt approved Maſters.

To give practical expertneſs to the pupils deſigned for ſea ſervice, there is in the play-ground a ſhip, which moves round on a ſwivel and caſtors; hath three maſts, rigging, ſails, yards, &c. and is ſufficiently large for twenty-four Young Gentlemen to go aloft at a time, whereby they are inſtructed to hand, reef, put a ſhip about, &c. &c. &c. A rigging-houſe is likewiſe provided, in which they learn to ſtrap blocks, knot, ſplice, fix rigging, &c.

For particulars of this eſtabliſhment (the only private one ever inſtituted in this Country, and the moſt comprehenſive in its object) the principals beg leave to refer to their plan, which may be had, price 6d. at the following places, viz. Mr. STOCKDALE's, Bookſeller, Piccadilly; Mr. COLE's, Mathematical-Inſtrument-maker, Fleet-Street; Mr. HOOPER's, oppoſite Southampton-Street, Holborn; and Mr. ELLIOTT's, Bookſeller, at Falmouth.

To all Commanders and Officers in the Navy; or such as are intended for a Naval Profession.

BETTESWORTH and Co. have opened a Naval Academy in Burgess-Place, [illegible] where all the various branches of science and polite accomplishments necessary for the qualification of Sea Officers and the accomplishment of Young Gentlemen, are carefully and expeditiously taught by the most approved Masters.

To give practical experience to the pupils designed for sea-service, there is in the play-ground a ship which moves round on a swivel and centre; [illegible] rigging, sails, yards, &c. and is sufficiently large [illegible] for Young Gentlemen to go aloft [illegible] they are instructed to hand, reef, [illegible] &c. &c. A rigging-house is likewise provided, where they learn to strap blocks, knot, splice, fix rigging, &c.

For particulars of this establishment (the only one ever instituted in this Country, and the most comprehensive in its object) the principals beg leave to refer to their plan, which may be had, price 6d. at the following places, viz. Mr. STOCKDALE's, Bookseller, Piccadilly; Mr. COLE's, Mathematical Instrument-maker, Fleet-Street; Mr. HOOPER's, opposite Southampton-Street, Holborn; and Mr. ELLIOTT's, Bookseller, Falmouth.

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